EXTAC 1007
MINE COUNTERMEASURES

ORIGINATOR: Belgian-Netherlands Mine Warfare School "EGUERMIN"

January 1996

April 1996

PUBLICATION NOTICE

ROUTING

1. EXTAC 1007, MINE COUNTERMEASURES, is available in the Naval Warfare Publications Library. It is effective upon receipt.

2. EXTAC 1007 is one of a series of publications designed for use in operations between NATO and non-NATO navies. It is a stand-alone document.

3. EXTAC 1007 is UNCLASSIFIED and for official use only. It may be duplicated and released to non-NATO nations independently by NATO nations, commands, and agencies as required.

Naval Warfare Publications Custodian

Naval warfare publications must be made readily available to all users and other interested personnel within the U.S. Navy.

Note to Naval Warfare Publications Custodian

This notice will assist you in providing information to cognizant personnel. It is not accountable.

BE-NL MINEWARFARE SCHOOL

EGUERMIN
3e en 23 Linieregimentsplein
B-8400 Oostende
Belgium

LETTER OF PROMULGATION

1 EXTAC 1007, Minecountermeasures, is one of a series of publications designed for use in operations between NATO and non-NATO navies. It is a stand-alone document.

2 EXTAC 1007 is UNCLASSIFIED and for official use only. It may be duplicated and released to non-NATO nations independently by NATO-nations, commands and agencies as required.

3 Changes to this EXTAC will have the same distribution as the original document. This means that nations, commands and agencies in para 2 are responsible for updating their own duplicated and released copies of this document.

Director
Belgian-Netherlands Minewarfareschool
EGUERMIN

J.J. van Iterson
captain Royal Netherlands Navy

DEPARTMENT OF THE NAVY
NAVAL DOCTRINE COMMAND
1540 GILBERT STREET
NORFOLK, VA 23511-2785

April 1996

U.S. LETTER OF PROMULGATION

1. EXTAC 1007, MINE COUNTERMEASURES, is one of a series of publications designed for use in operations between NATO and non-NATO navies. It is a stand-alone document.

2. EXTAC 1007 is effective on receipt.

3. EXTAC 1007 is UNCLASSIFIED and for official use only. It may be duplicated and released to non-NATO nations independently by NATO nations, commands, and agencies as required.

M. L. BOWMAN
Rear Admiral, U.S. Navy
Commander, Naval Doctrine Command

NOTE TO U.S. HOLDERS — Report any page shortage by letter to NAVTACSUPPACT (copy to NDC). Order a new publication or change, as appropriate, through the Navy Supply System.

RECORD OF CHANGES

Identification of Change, Reg-.No. (if any) and Date	Date Entered	By Whom Entered (Signature; Rank, Grade or Rate; Name of Command)

RECORD OF CHANGES

Identification of Change, Reg-.No. (if any) and Date	Date Entered	By Whom Entered (Signature; Rank, Grade or Rate; Name of Command)

Table of contents

Section 4 NAVIGATION IN MCM

Section 5 ENVIRONMENTAL FACTORS AFFECTING MCM

Section 6 BUOYS IN MCM

Section 7 FORMATIONS AND TURNS IN MINESWEEPING

CHAPTER 2 MECHANICAL MINESWEEPING

Section 1 MECHANICAL SWEEPS

Section 2 EXECUTION OF MECHANICAL SWEEPING OPERATIONS

Section 3 CONVENTIONAL WIRE SWEEPING FORMATIONS

Section 4 WIRE TEAM SWEEPING FORMATION

Section 5 STATION-KEEPING IN MECHANICAL FORMATION SWEEPING

CHAPTER 3 INFLUENCE MINESWEEPING

Section 1 INFLUENCE SWEEPING

Section 2 EXECUTION OF INFLUENCE SWEEPING OPERATIONS

Section 3 INFLUENCE MINESWEEPING FORMATIONS

CHAPTER 4 MINEHUNTING

CHAPTER 5 CLEARANCE DIVING OPERATIONS

CHAPTER 6 MW-MESSAGES

Section 1 INTRODUCTION

CHAPTER 7 MINE DISPOSAL EXERCISES

CHAPTER 8 PLANNING AND EVALUATION

Section 1 GENERAL

Section 2 MCMV RISK AND SAFETY

Section 3 CLEARANCE OPERATIONS

Section 4 EXPLORATORY OPERATIONS

CHAPTER 9 SAFETY ASPECTS

PREFACE

1. PURPOSE. The purpose of this EXTAC is to provide guidance and common doctrine for Mine Countermeasures (MCM) Forces. It is the governing MCM publication and covers MCM planning, mine threat and mine countermeasures exercises and operations. This publication is intended for the operational and the tactical level.

2. Associated Publications. Associated publications are those of the EXTAC 1000-series.

   Special reference has been made to the following publications:

EXTAC 1000	Maritime manoeuvring
EXTAC 1009	Diving safety
ATP 10	Search and Rescue

3. Comments and recommended changes to this document should be sent directly to the address listed below:

   DIRECTOR
   BELGIAN-NETHERLANDS MINEWARFARESCHOOL "EGUERMIN"
   3e en 23e Linieregimentsplein
   B-8400 Oostende
   Belgium

CHAPTER 1

MINE COUNTERMEASURES GENERAL

SECTION 1

INTRODUCTION TO MINE COUNTERMEASURES

0101. INTRODUCTION

This chapter discusses in general terms mine countermeasures (MCM) in exercises and operations, their organisation, and interdependence. It aims to give a broad overall picture of MCM. The following chapters expand on details and factors constituting the principles of MCM.

0102. GENERAL

The purpose is to set forth the fundamental principles of MCM. The factors affecting these principles, such as the conduct of operations, logistic support, navigation, self protective measures and environmental influences are discussed in the following chapters.

0103. RELATIONS BETWEEN MCM

Relations between MCM-operations are shown in fig 1-1. This EXTAC will deal with defensive MCM-operations only.

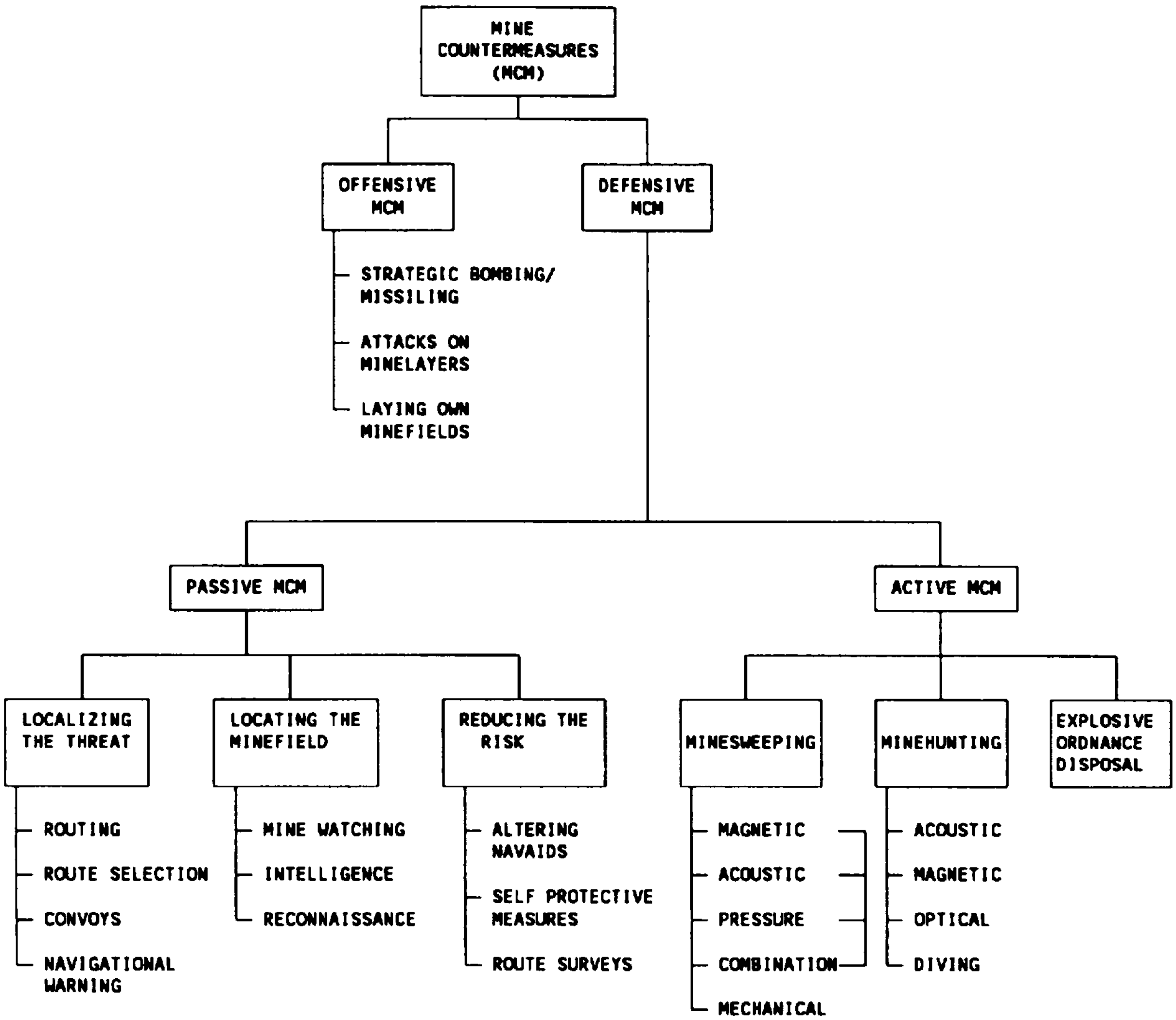


fig 1-1. The MCM Family Tree

0104. COMMAND AND CONTROL IN MCM

a. Command

Command is the authority vested in an individual to direct, coordinate, and control forces. The aim of command is to provide a single authority responsible for operational efficiency. Some functions arising from direction, coordination, or control may be delegated to subordinates. However, this is normally only done in large or widely dispersed task organizations (see also EXTAC 1000)

(1) *DIRECTION*
The process of planning, establishing priorities, formulating policies, and imposing decisions.

(2) *COORDINATION*
The establishment of planned actions to achieve the best overall result. In the maritime environment, the term coordination may include a certain specified control function.

(3) *CONTROL*
The authority exercised by a commander over part of the activities of subordinates. Control includes the responsibility for implementing orders or directives. All or part of this authority may be transferred or delegated.

The aim of command is to achieve the maximum operational and/or administrative efficiency.

b. Command Levels

Various levels of command exist: operational command, operational control, tactical command, and tactical control. The following paragraphs define each of these levels.

(1) *OPERATIONAL COMMAND (OPCOM)*
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 and/or tactical control as may be deemed necessary. Operational Command is beyond the scope of this EXTAC.

(2) *OPERATIONAL CONTROL (OPCON)*
OPCON is the authority to direct forces assigned in order to 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. It does not include the authority to assign separate employment of components of the units concerned. Neither does it, itself, include administrative or logistic control.

(3) *TACTICAL COMMAND (TACOM)*
TACOM is the authority to assign ships to specific tasks within an exercise or operation. It involves issuing detailed orders and ensuring their correct execution. It also involves responsibility for the general safety of assigned units, although ultimate responsibility for safety remains with the commanding officer of each unit. TACOM does not include the authority to assign tasks inconsistent with the exercise or operation. TACOM is assigned to the CTG of a specific exercise or operation.

(4) TACTICAL CONTROL (TACON)
TACON is the authority to direct and control the movements or manoeuvres of ships to accomplish the exercise or operation. TACON is assigned to the CTG and may be delegated to subordinate CTUs or CTEs.

c. Change of Operational Control

Change of operational control (CHOP) occurs when it is intended that operational control of a force or unit pass from one operational control authority to another. The operation order should state in explicit terms the manner of execution of CHOP. This may be done in terms of time (UTC), position, or boundary crossing.

0105. AUTHORITIES AND RESPONSIBILITIES

The authorities and responsibilities related to the above mentioned command levels can be summarised as follows :

a. The OPCON Level

(1) Controls assigned MCM forces in his area.

(2) Coordinates the overall MCM effort.

(3) Promulgates Exercise or Operations Orders including organisation and acceptable risks to units.

(4) Assigns operational responsibility for specific areas to subordinate commanders.

(5) Collates, analyses and disseminates intelligence information.

(6) Establishes routes.

(7) Initiates promulgation of navigational warnings.

(8) Despatches periodical reports to higher authorities.

b. The TACOM Level

The Tactical Command Level has the responsibility for the tactical function of ordering tasks to allocated MCMVs within the area of command. The commander should be assisted in this function by a small staff. Preferably the commander is afloat in a suitable command/support platform. His responsibilities are to:

(1) Coordinate the MCM effort in his local area and assign MCM forces to individual tasks which involve operational control of MCM forces in his local area.

(2) Issue MCM task orders in accordance with current orders, modifying these instructions as necessary to meet the threat.

(3) Recommend to the OPCON authority the issue of navigational warnings.

(4) Order the temporary, partial or total closure of ports and anchorages within his area when authorised.

(5) Despatch appropriate reports to the OPCON authority.

(6) Compile reports and records.

(7) Order the appropriate task cycle if necessary for each type of MCM unit.

(8) Provide support to assigned MCM forces.

c. The TACON level

The Officer in Tactical Control (OTC) is responsible for the actual conduct of tasks allocated to him. This implies the authority to direct and control the movements or manoeuvres of ships to accomplish the exercise or operation.

0106. COORDINATION

The following areas should be considered by the Commander as essential for the overall coordination of the mission:

a. MCM operations may hamper, or even prevent operations of other naval units and sailing of own merchant ships, transiting independently or in convoys. Timely coordination between all authorities concerned and proper warning will minimise interference.

b. If MCM operations have to be protected, in case opposition is to be expected, this support has to be arranged in time and is to be coordinated with ongoing operations, as normally no spare units will be available to protect MCM forces.
If the main threat is seen to come from enemy aircraft, it is very important to include MCM forces into the air defence organisation.

c. When MCM units are carrying out tasks independently near each other, it becomes necessary to coordinate their actions to prevent the destruction of these units by own or enemy mines and to avoid the loss of effectiveness resulting from manoeuvres intended to prevent interference and also to avoid interference between units. For this reason, MCM must be controlled by one responsible officer in each headquarters and coordination with adjacent command authorities is a necessity.

0107. DAMAGE EFFECT

a. For every ship and MCM unit there is a **damage radius** within which a mine containing a given weight and type of explosive must explode if the ship is to receive appreciable damage. From a combination of action experience and scale models, specific figures for damage radii can be evolved.

b. Damage to helicopters and hovercraft due to underwater mines can be produced by the water plume, fragmentation and air shock. Damage due to air shock will not be significant for most cases of practical interest.

0108. INTELLIGENCE

a. The necessity for good intelligence cannot be overstressed. It has a vital effect on all phases of planning, execution of operations and evaluation of MCM techniques. In particular the officers concerned with the process of planning must have direct access to the best sources of intelligence available, mainly to be able to diminish the risk to own naval MCM forces to an acceptable level.

b. It remains the responsibility of the overall Commander to disseminate all pertinent intelligence information pertaining to mines.

0109. LOGISTICS

a. Philosophy

Generally, logistic support of MCM forces is a national responsibility. However, every effort should be taken to mutually benefit from pooling of logistic assets.

b. Special Aspects

Logistic support is an integral part of the function of MCM. To fulfil the aim of MCM, special logistic aspects have to be considered in the planning and conduct of MCM operations taking into account, the special needs of minesweepers, minehunters and clearance diving teams. These matters require a great deal of external support particularly in forward operational areas.

0110 - 0119. SPARE

SECTION 2

OBJECTIVES OF MCM

0120. AIM OF MCM

The aim of MCM is to permit ships to use the seas and enter and leave ports as necessary without unacceptable damage or losses from mines. This aim can be achieved by :

a. Causing the mines to explode without loss, or with acceptable loss to the shipping by the use of mine countermeasures forces.

b. Causing the mines to become ineffective by removing them to a safe place or by preventing the firing mechanism from operating.

c. Reduce the danger to shipping by confining ships to routes in which hostile mines are scarce or nonexisting either because mines have not been laid in quantity or because their number has been reduced by the actions of MCM forces.

0121. MISSIONS

MCM missions are to reduce the effectiveness of enemy mining missions, and to clear friendly mines. The achievement of an MCM mission may require that a number of specific goals are identified. These goals can be, but are not limited to:

a. Determining the presence or absence of mines.

b. Locating non-mined waters.

c. Reducing danger presented by mines.

0122. MCM RISK DIRECTIVES

a. When determining the proper MCM tactics and techniques, one is usually constrained by the time allowed to complete the operation and the risk to which one may subject the MCMV.

b. Three degrees of Risk Directives are used in MCM and are defined as follows:

(1) RISK DIRECTIVE ALFA.
The primary concern is to minimize the risk to the MCM asset(s). The timely completion of the task is of secondary importance.

(2) RISK DIRECTIVE BRAVO.
Balance the risk to the MCM asset(s) and the time available, in order to complete the task.

(3) RISK DIRECTIVE CHARLIE.
The primary concern is the timely conclusion of the task. Risk to MCM asset(s) is of secondary importance

Note 1:
When used, Risk Directives are ordered by the OPCON Authority.

Note 2:
It remains a national responsibility to provide the Commander with directions concerning the risk to which MCMVs may be subjected, in each MCM directive.

0123. MCM TECHNIQUES

A MCM technique is the operation of a specific MCM vehicle and its equipment in a particular way. Factors such as towing speed, sweep modulation, sweep output and the manner of towing is included in specifying a minesweeping technique. The use of two or more sweeps at the same time by a single sweeper constitutes a combination sweeping technique. A minehunting technique is the joint operation of the components of a particular minehunting system in a particular way.

0124. MCM METHODS

A MCM method is the manner in which one or more MCM techniques are used. It concerns the separation or formation of MCMVs, the lateral distance between tracks, the order and number of runs made on each track and similar considerations.

0125. MCM STAGES

A MCM stage is the use of a specific MCM technique to counter a particular type of mine. Different MCM stages, their choice and their sequence are discussed in the separate chapters.

0126. MCM TASKS

A MCM task is a stage or combination of stages related to a specific channel or area of execution, time of execution, and MCM means for the execution.

0127 - 0129. SPARE

SECTION 3

MCM OPERATIONS

0130. ACTIVE MCM OPERATIONS

This EXTAC deals with the following MCM operations:

- Precursor MCM operations: The sweeping or hunting of an area by relatively safe means in order to reduce the risk to MCMVs in subsequent operations,

- Exploratory MCM operations: Aimed at determining the presence or absence of mines in a given area,

- Clearance MCM operations: Intended to achieve a high probability of sweeping/hunting any mine in an area.

Further, a number of specific tasks are not considered as MCM operations but may be undertaken by MCMVs.
Amongst these are:

- Lead through operations: To assist traffic in the transit of parts of a mined area which previously have been subject to MCM effort (See Annex G).

0131. PASSIVE MCM OPERATIONS

Passive defensive MCM operations are prepared and will be ordered for non-MCMVs with the aim to protect them against the threat from hostile mines. This EXTAC will deal with the following passive MCM operations/techniques:

- Localising the threat (routing, navigational warnings),

- Locating the minefield (intelligence, strategic reconnaissance, mine watching) and

- Reducing the risk (self protective measures)

0132. ORDERING AN OPERATION

Ordering a MCM operation may be done by either a MCM Operation Order, which is a manuscript order, or by the use of messages. The details of these are given in Annex A. For the ordering and conduct of MCM operations by messages, the two following messages/signals are used :

- MCM Operations Direction (MCMOPDIR) and

- MCM Task Order.

The difference between the two is the level of appliance, but the operation will be dependant on the carefulness of the drafter when issuing the orders.

0133. MCM OPERATIONS DIRECTION

The MCM Operations Direction (MCMOPDIR) is used by the Commander to order in general execution of MCM operations by subordinate commanders.

a. Identification

MCMOPDIRs are identified by a three digit number. MCMOPDIRs are numbered consecutively to facilitate identification and to make easy reference.

b. Instructions

All MCMOPDIRs must have a number, but the individual paragraph will only be used when applicable.

c. Structure of the MCMOPDIR

See Annex B.

0134. MCM TASK ORDER

MCM Task Orders are used to allocate a variety of specific tasks necessary to accomplish the entire operation. The format can be found in Annex C.

0135. EXECUTION OF TASK ORDERS

The OTC decides how to execute his task. He is responsible for the proper execution of all task orders within his MCM force. He will give necessary additional instructions as the development of the situation dictates, and will keep his superiors informed. (See Annex C).

0136. MCM REPORTING

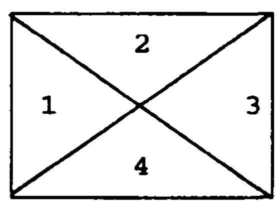
Mine countermeasures reports (MCMR) are the only means various levels of command have to obtain up to date information on the state of own mine countermeasures. A full list of MCM reports and records is given in Chapter 6.

0137. RUN TOTE

a. Each effective sweep passage constitutes a run on that particular track. For reporting purposes runs are numbered consecutively from 1 on each track, and each ship must maintain a tote of the run numbers of his group. If sweeps do not function throughout a run, it is ineffective and a number must not be allocated to it. To avoid confusion, each ship should broadcast to the unit, at the beginning and end of each run, the track number. From time to time, and when a ship joins the unit during the task, the OTC must confirm the 'run tote' by signalling the numbers of the runs actually in progress, or by signalling the totals of the run tote.

b. Instructions for Completing the Run Tote

(1) Part 1 : Time of entering track.
Part 2 : E (for 'effective') followed by the run number.
M In combined sweeping, effective only for magnetic sweeping.
A In combined sweeping, effective only for acoustic sweeping.
O In combined sweeping, effective only for mechanical sweeping.
Part 3 : Time out of track.
Part 4 : Name or call sign of ship making run.



(2) If the run is ineffective, the appropriate rectangle will be scratched.

0138 - 0139. SPARE

SECTION 4

NAVIGATION IN MCM

0140. GENERAL

A primary factor influencing the selection and conduct of the proper MCM objective and having a direct impact on the type and number of MCM assets required for an adequate defence against mines is the accuracy and means of navigation. The following paragraphs provide specific examples of tasks in which accuracy of navigation is particularly important.

a. Geodesy

(1) *THE GEOID*
The (earth) geoid is a surface of equal gravitational potential, which corresponds approximately to mean sea level, to which the direction of gravity is always perpendicular. The universally accepted best approximation of the shape of the earth, is what is meant when referring to the earth's size and shape. The geoid is not the same as the earth's topographical surface, but, it is irregular, because of uneven distribution of mass. However, although the geoid is a convenient medium in which to study gravity, it has disadvantages if horizontal coordinates of points, distances and angles are to be calculated, because the relevant mathematical formulae become unmanageable. Another disadvantage; the geoid is not completely known, because the knowledge of the gravity field of large areas of the earth is incomplete. For these reasons, the geoid is unsuitable as a model for chart-making purposes.

(2) *THE OBLATE SPHEROID*
Since the earth flattens at its poles of rotational axis and bulges at its equator, the geometrical figure most nearly representative is an oblate spheroid. This is the shape of the earth as postulated by Sir Isaac Newton and it has proven to be that figure best suited to chart-making. An oblate spheroid is obtained by rotating an ellipse about its minor axis (i.e. an ellipsoid or revolution). An ellipsoid is used in chartmaking because it is regular and, therefore, less complicated than a geoid. Its defining parameters are semi-major axis and flattening. Flattening is the ratio of the difference between the semi-major and semi-minor axes to the semi-major axis. However, an ellipsoid, unlike the geoid, has a regular surface and therefore only approximates the geoid. This approximation is the first source of chart errors.

(3) REFERENCE ELLIPSOIDS
Many attempts have been made to define that ellipsoid which most closely approximates the shape of the earth. Universal acceptance of a single ellipsoid is difficult to obtain, however, as mean figures for the entire earth are not always the best for surveying a particular region. An ellipsoid which fits well in Europe for example, does not fit well in North America. Ellipsoids which fit better locally are preferred for surveying and charting.

(4) GEODETIC DATUMS
A geodetic datum is defined by an ellipsoid and by the relationship of the Earth to that ellipsoid e.g. spheroidal coordinates at an origin. One result is that reference points given with respect to one datum and ellipsoid may differ from the same points given with respect to another. This means that the same prominent landmark will have different latitude and longitude on charts having different datums. To provide common reference for a coherent area, datums of at least continental limits are necessary.

(5) PREFERRED DATUMS
One solution has been the establishment of a preferred datum for an area, adjusting all local systems to it. Information on some ellipsoids and datums is given at Table 1-1 and discussions on a few follow;

(a) The North American Datum 1927. Origin Meades Ranch, Kansas, US, is based on the Clarke 1866 Ellipsoid and includes, inter alia, North and Central America.

(b) The European Datum 1950. Origin Potsdam, GDR, incorporates various national systems and uses the International Ellipsoid 1924 (Hayford 1909). European, African, and Asian triangulation chains and connecting data from the Russian Pulkova 1932 extend the system east to the 84th meridian.

(c) The Ordnance Survey of Great Britain 1936 Datum. Based on the Airy 1849 Ellipsoid, has no point of origin. Its origin is derived as a best fit between retriangulation and original values of 11 points of the earlier Principal Triangulation of Great Britain (1783-1885).

(d) The Tokyo Datum. Origin Tokyo, Japan, is defined in terms of the Bessel 1841 Ellipsoid.

(e) The Indian Datum. Origin Kalianpur, India, is preferred by India and several South-east Asian countries. Based on one of the oldest and smallest ellipsoids, the Everest Ellipsoid 1830, the Indian Datum is the least satisfactory of the preferred datums.

(f) World Geodetic Systems (WGS) Datum. The WGS is a geocentric (earth-centred) system which provides a common reference for establishing compatibility among coordinates of interest in different geodetic networks. The first World Geodetic System, WGS 60, a best-fitting ellipsoid for major datums, used the nodal motion of Satellite 1958ß to provide the value for ellipsoid flattening and semi major axis. With additional data and better defining parameters, another WGS Committee produced the WGS 66 Ellipsoid. Datum shift constants for the North America 1927, European and Tokyo Datums were developed. With still more data and greater computer capability, a WGS Committee defined WGS 72. The latest designation is WGS 84. Most newer charts cite conversion factors for reference to WGS Datum.

PREFERRED DATUM NAME	ORIGIN OF DATUM	ELLIPSOID OF BASE	AXES (radii)metres)		FLATTENING (f=1-b/a) (1/..)f)
			SEMI-MAJOR EQUATORIAL (a)	SEMI-MINOR POLAR (b)	
Indian	Kalianpur India	Everest 1830	6377276.35	6356075.41	300.80
Tokyo	Tokyo Japan	Bessel 1841	6377397.16	6356078.96	299.15
Ord Survey GB	None (Based on UKAverages)	Airly 1849	6377563.40	6356256.91	299.32
N America 1927	Meades KA, US	Clark 1866	6378206.40	6356583.80	294.98
African Arc	Buffles-fontein SA	Clarke 1880	6378249.15	6356514.87	293.47
European 1950	Potsdam, GDR	Interna-tional 1924 (Hayford 1909)	6378388.00	6356911.95	297.00
Mercury	Earth Centred	Fisher 1960	6378166.00	6356784.28	298.30
Mercury	Earth Centred	Fisher (SE Asia)	6378155.00	6356773.32	298.30
Mercury	Earth Centred	Fisher 1968	6378150.00	6356768.34	298.30
Australian	Johnston, AUS	Australian Nat	6378160.00	6356774.72	298.25
WGS 60/66 72/84	Earth Centred	WGS 60/66/ 72/84	6378135.00	6356750.52	298.26

Table 1-1. Reference Datums and Ellipsoids

Note. *NAVSTAR GPS ellipsoidal parameters shown for WGS 72 ellipsoid only.*

b. Designating Positions

Ordering or reporting positions can be done in a number of different ways. The following methods are all used in MCM:

(1) *LATITUDE AND LONGITUDE*
Latitude and longitude are normally expressed in degrees, minutes and seconds or degrees, minutes and decimals of minutes. Leading zeros are required to fill latitude to five and longitude to six digits. Entries are to be separated by a hyphen (-) and each entry shall include a check-sum (e.g. 663412N2-0041502E2). The chart datum must always be specified.

(2) *UNIVERSAL TRANSVERSE MERCATOR (UTM) GRID*
Full position expressed in UTM-grid coordinates is given in:

GRID ZONE DESIGNATOR	(e.g. 31 U)
100 KILOMETRE SQUARE IDENTIFIER	(e.g. ET)
EASTING 2-5 DIGITS	(e.g. 36630)
NORTHING 2-5 DIGITS	(e.g. 56861)

The grid zone designator, separately or together with the 100 kilometre square identifier, may be omitted in local operations where ambiguity is not likely to occur. (e.g. ET 3663056861).

(3) *BEARING AND DISTANCE FROM A REFERENCE POINT*
A position expressed in bearing and distance from a reference point is given in true bearing in degrees as three digits, reference point as two letters, distance in nautical miles (e.g. 170EE12.5).

(4) *POSITION ON THE ROUTE*
A position on the Route (or channel centre line) is expressed by an alpha-numeric group from Route description (e.g. 250A is the position of point Alfa of Route 250). Parts of the Route (or channel centre line) are expressed by the position on the Route, followed by the distance along the route (or channel centre line), in nautical miles, going in alphabetical directions. (e.g. 60A2.5 to 60B2 means the part of Route 60 that is 2.5 nautical miles past position 60A to a point 2 nautical miles past position 60B).

(5) *POSITION IN THE VICINITY OF THE ROUTE*
The position in the vicinity of the Route is expressed by an alpha-numeric group composed in the following way. Position on the Route (or channel centre line) see subparagraph (4) above. Indication + (PS) or - (MS) from the Route (or channel centre line) (seen in alphabetical direction, PS to the right, MS to the left). Lateral distance in tens of yards (e.g. 60A2.5PS10).

The method of reporting to be used depends on the requirement in the various formats or Operations Orders, but in general the following may be stated:

METHOD	WHEN
Latitude and Longitude	To indicate and report positions on Routes, and in channels
UTM Grid	
Position on a Route	To indicate positions in tasking
Positions in vicinity of a Route	
Bearing and distance	To report positions in an anchorage or when using reference positions

Table 1-2. Methods of position indicating.

c. Track/Buoy Designation

Track/Buoy designation is used in accordance with subpara (5) above. (see also Figure 1-3).

0141. NAVIGATIONAL SYSTEMS IN MCM

Some examples of navigational systems which are available for the use of MCMV and transiting vessels and values indicating estimated system position-fixing accuracy are shown in table 1-3. These values should not be taken as absolute but as being relative to the system used. The values are useful however, because they indicate the relative accuracy to which one can navigate within the system.

TYPE	PRINCIPLE and METHOD		SYSTEM ACCURACY
Acoustic	Beam Riding	- Acoustic beam	1.5°
	Doppler	- Acoustic doppler	0.3 % Dist
	Responder	- Telemetry	0.5m
	Terrain Follower	- Natural Features	0.5m
	Terrain Follower	- Artificial Features	0.5m
	Tracking	- Short Baseline	0.2m
	Tracking	- Ultra-Short Baseline	1 % slant range
	Transponder	- Active/Passive Beacon	< 1m
Inertial	Accelerometer	- Inertial	2 %/sec
	Gyrocompass	- North Seeking	35-90m
	Gyrocompass	- Ring Laser	0.02 %
	Pendulum	- Inertial	0.5 %
Magnetic	Compass	- North Seeking	3°
	Compass	- Triaxial Flux Gate	2°
Optical	Rangefinder	- Bifocal	5 % slant range
	Rangefinder	- Infra-Red	15mm
	Rangefinder	- Laser	0.1m
	Theodolite	- Laser	0.1m
	Theodolite	- Conventional	0.5m
	Sextant	Horizontal Sextant Angles	25m
Radio	Direction Finder	- Radio	500m-2°
	Direction Finder	- Continuous Wave	10m
	Hyperbolic	- Continuous Wave	10m
	Hyperbolic	- Pulsing	3m
	Range-Bearing	- Radar	70-90m
	Range-Range	- Beacon	1m
	Range-Range	- Radar	10m
	Satellite	- GPS (NAVSTAR)	5m
	Satellite	- NAVSAT (TRANSIT)	50m

Table 1 - 3. Navigation Systems

0142. COMMON CAUSES OF NAVIGATIONAL ERROR

Some common causes of navigational error are:

- Angle at which Lines of Position (LOP) intersect.
- Number of LOP used.
- Charts upon which positions and tracks are plotted.
- Distance from a reference point or baseline.
- Environmental or climatic conditions.

- If being used location of towers or transmitters.
- Proficiency and training of navigation crew.
- Time interval since last navigational update.
- Time of day.

0143. MARKING OF ROUTES AND CHANNELS

It is easier for traffic to keep within a channel if it is adequately buoyed. (For detailed information see Chapter 1 Section 6).

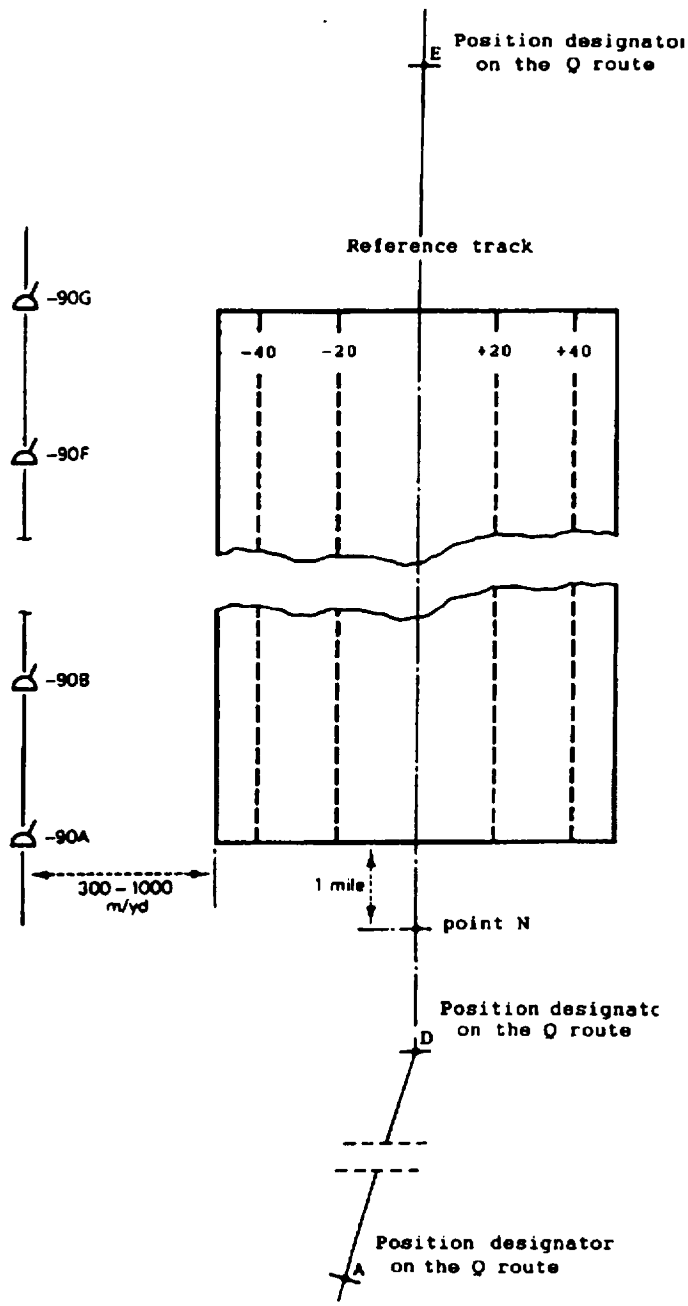


fig 1-3 Buoys and tracks designation

0144. LIGHTS

a. MCMVs are to comply with the International Regulations for the Prevention of Collisions at Sea (IRPCS) and use the prescribed lights, daymarks and fog signals.

b. Stationkeeping Lights

In addition to the lights required by the IRPCS, the following lights should be fitted in minesweepers for stationkeeping purposes: two white lights vertically disposed one above the other, each light to be visible from 20° before the beam on one side through the stern to 20° before the beam on the other side. The two lights are to be 9m apart in MSOs and 6m apart in MSC and MSI. The lights are to be controlled by dimming to provide a visibility range from 200 yards (183m) to 2 nautical miles (3.70 km). Both lights are to be screened from above. In the smaller sweepers, where it may not be possible for the lower of the two lights to be visible over the entire arc in one light fitting, two light fittings may be provided to cover the entire arc.

c. Pulse Indicating Lights

Minesweepers of all types capable of sweeping with pulsed magnetic sweeps are to be fitted with Pulse Indicating Lights to their own national requirements.

d. Helicopter Lights

In addition to the lights required to be shown by international civil or military aircraft regulations, helicopters engaged in minesweeping or towed minehunting are to show a quick-flashing amber light visible all round from below. Towed gear is to show the appropriate lights as prescribed in international regulations.

0145 - 0149. SPARE

SECTION 5

ENVIRONMENTAL FACTORS AFFECTING MCM

0150. GENERAL

a. In no other phase of coastal warfare do environmental considerations in both tactics and planning play a more dominant role than in MCM. Mine cases, mine sensors, target signals, and MCM sweeps, sonars, signals and operations are all affected in varying degrees by a large number of environmental factors. Many of these are of major importance and may decide a go/no-go situation or determine the selection of MCM equipment or procedures. In fact the basic decision in MCM, to determine the location and limits of minefields or to sweep or hunt an area and destroy the mines, is based to a large extent on an assessment of the environmental situation. The procedures for selecting sweeping and hunting techniques similarly depends upon knowledge of the operational environment.

b. Automated Data Processing

Whenever possible automatic data processing should be used in the collection and dissemination of environmental data required for planning and conducting MCM operations.

0151. INFLUENCE OF STABLE ENVIRONMENTAL FACTORS ON MINESWEEPING OPERATIONS

The following stable environmental factors affect mechanical and influence minesweeping operations:

- water depth
- bottom topography
- bottom composition
- underwater and surface obstacles
- prominent landmarks
- geographic location
- magnetic sweeping environment
- acoustic sweeping environment

0152. INFLUENCE OF TEMPORARY ENVIRONMENTAL FACTORS ON MINESWEEPING OPERATIONS

Various temporary environmental factors influence minesweeping operations. These factors include:

- tides
- tidal streams and currents
- climate and weather
- wind
- air temperature and air pressure
- visibility
- wave action and sea swell
- marine life

0153. INFLUENCE OF STABLE ENVIRONMENTAL FACTORS ON MINEHUNTING OPERATIONS

The following stable environmental factors affect minehunting operations:

- water depth
- bottom topography
- bottom composition
- bottom reverberation
- bottom clutter *
  (1) Operational minehunting clutter(OPS MH CLUTTER)
  (2) Minelike echo (MILEC)
  (3) Minelike contact (MILCO)
  (4) Non-mine minelike bottom object (NOMBO)
- underwater visibility
- water density
- underwater and surface obstacles
- magnetic hunting environment

* for definition of terms see Glossary (Annex L)

0154. INFLUENCE OF TEMPORARY ENVIRONMENTAL FACTORS ON MINEHUNTING OPERATIONS

a. Minehunting operations may be affected by temporary environmental factors such as:

- tidal Streams and Currents
- climate and weather
- acoustic minehunting environment
- magnetic minehunting environment

0155. MINEHUNTING SONAR FORECAST

a. Minehunting Sonar Forecast Reports should become a standard headquarters service for minehunters which are not able to make their own calculations.

b. For this purpose the minehunter has to signal results of own sound velocity or bathy readings to the responsible headquarters.

c. Nevertheless, each minehunter should be equipped with real time performance measuring equipment to determine minehunting sonar performance at a specific time and place.

0156. EFFECT OF STABLE ENVIRONMENTAL FACTORS ON CLEARANCE DIVING OPERATIONS

Clearance diving operations may be effected by the following stable environmental factors:

- Water depth
- Bottom topography
- Bottom sediment

0157. EFFECT OF TEMPORARY ENVIRONMENTAL FACTORS ON CLEARANCE DIVING OPERATIONS

The following temporary environmental factors might influence clearance diving operations:

- weather
- current

- water density
- sea water temperature
- marine life
- sea swell

0158 - 0159. SPARE

SECTION 6

BUOYS IN MCM

0160. GENERAL

a. Types of Buoys

(1) *PERMANENT BUOYAGE*
Channels are usually marked with permanent buoys prior to minelaying or, after MCM operations, by special vessels. Permanent buoys are able to withstand heavy weather for prolonged periods, whereas MCM buoys are inadequate for permanent buoyage. Permanent buoys laid prior to mining fix the channel; after MCM operations, MCM buoys fix the channel.

(2) *MCM BUOYS (DANBUOYS)*
Even with precise navigation, MCM buoys must not be overlooked. Their principal use is to mark out the areas of past, present, or future MCM operations. The tactics and stationing of MCM buoy and dan layers is laid down in section 5 of this chapter. The OTC is responsible for deciding the distance apart of danbuoys according to visibility, radar range, and sea state; however, buoys normally should be 1 to 1.5 miles apart. A rule of thumb is that the guide should be able to see two buoys ahead. For observation at a distance the buoys may be fitted with signal flags, radar flags, radar target/reflectors and/or fixed or flashing lights. If MCM buoys have radar reflectors, the guide or any transiting ship may keep station on the line of MCM buoys with radar; if they do not have radar reflectors, the guide/transiting ship may use the buoy layer as a reference. Mine countermeasures buoys can be carried and laid by most naval and civilian vehicles, provided they are adequately equipped.

b. Methods of Marking

(1) *CENTRELINE BUOYS*
Buoys laid on the centreline of a route or channel are most useful for long distances. The centreline buoy method offers the advantages that it is easier for shipping to follow and lessens the likelihood of collisions between ships proceeding in opposite directions. It suffers from the disadvantage that it is difficult to sweep (but not to hunt) close to a buoy, which can cause holidays in the centre of the channel.

(2) *OFFSET BUOYS*
Buoys laid on one side of a route or channel may be the most useful to minesweepers because they can then operate without fouling gear in buoy mooring.

c. MCM buoy-laying can be conducted either before, during or on completion of MCM operations. Buoy-laying before and during the operation is usually designed to assist the MCM forces to avoid gaps in the coverage. Buoy-laying after operations are completed is usually confined to more permanent marking of the channel or area to assist transitting shipping.

d. In the absence of a precise navigation system, it is essential to lay a master reference buoy in the area of operation. The master buoy is designated as the 'datum buoy'. The position of the datum buoy is fixed as accurately as possible and therefore all buoys are laid relative to the datum.

e. The requirement to lay navigational buoys for MCM operations imposes a degree of risk. Consequently some form of precursor operation may be required and the buoy-laying phase must be planned and conducted with the same care that is given to any MCM operation. When deciding which is the most suitable vehicle for the buoy-laying task the following options should be considered, if no buoy-laying support from other vessels is available to the MCM unit:

(1) If a minehunter is available and minehunting conditions are known to be favourable, the hunter can be used in the buoy-laying role. In these circumstances the minehunter would be responsible for its own self-protection.

(2) If a minehunter is not available or if minehunting conditions are unfavourable, the buoys may be laid by any vessel and a precursor sweeping operation may thus be necessary.

(3) In some cases it may be possible to use a helicopter to lay buoys, but this may also require a controlling ship.

f. The task order should define the required position of the buoy-sinkers after taking into consideration:

(1) The navigational and track-keeping capabilities and the plotting and recording facilities of the MCM units.

(2) The period of the lay and the efficiency of the MCM buoys during the lay.

g. National publications contain information on the characteristics of various buoys. It should be made known to other participants what these characteristics are prior to an operation or exercise. This information contains, among others, a relationship given as a function of the depth and maximum current, between the length of mooring cable and the number of auxiliary floats to be used for the principal types of MCM buoys in use.

h. To ensure uniformity, all other MCM operations should be marked, prior to, during or after operations, by MCM buoys laid using the same principles.

i. When laying buoys or markers in areas adjacent to areas which have been searched or are in the process of being searched, the buoys already marking those areas are to remain in situ until the operation is completed, or until ordered by the OTC. This should avoid confusion, mistakes and errors in navigation.

0161. BUOY-LAYING BEFORE MCM OPERATIONS

a. In a Channel

When additional buoyage is required for MCM operations in a channel or route, the OTC will order offset buoy-laying in preference to centreline buoy-laying (see Fig 1 - 3 and para 0160b) as this avoids "holidays" in mechanical as well as in influence sweeping, and facilitates sweeping, hunting and diving. In offset buoy-laying the buoy sinkers will form one or two lines on the ground parallel to the channel's axis at a distance which may vary from 300 to 1000 yards off the edge(s) of the channel. It will then be possible to sweep, however strong the drift may be and whatever sweeping gear is streamed, and also, in statistical sweeping, it will be possible to take account of the edge-effect.

b. In an Area

When additional buoyage is required in the area of operations these buoys are usually laid to mark out the limits of the area and to mark the buoy sinker's track relative to the reference track. In large areas, it may not be practicable to mark out the area limits, but only the parts of the area in which MCM operations are being conducted.

0162. BUOY-LAYING DURING MCM OPERATIONS

a. In a Channel

(1) Buoy-laying during MCM operations in a channel is a complex operation requiring extensive arrangements, which is carried out only in mechanical sweeping. The MCM buoys are laid astern of the formation to mark the limits of the swept track. The buoy-laying may be carried out either on the wing, to mark out the track limit on the side of the formation, or astern of the guide, to mark out the track limit on the side of the guide, or on both sides at once.

(2) The OTC defines the buoy sinker's track by fixing the distance (Fig 1 - 4) between this and the reference track. It is necessary to ensure that in all cases the overlap will be effective. Allowance must be made for buoys' scopes, and strength of currents.

b. In an Area

The above rules apply during MCM operations in an area.

0163. BUOY-LAYER's TASK

a. Laying Buoys

A ship tasked to lay or recover MCM buoys is called a 'MCM buoy-layer'. Such vessels are not necessarily MCMVs but apply the same self protective measures as MCMVs with which they are working. They perform buoy-laying as follows:

(1) The buoy-layer has to ensure that the sinkers sink down on to the prescribed track from 300 to 1000 yards off the edge(s) of the channel or the ordered distance from the reference track. He should consider the drift of the sinker while sinking to the bottom and he should accordingly set off his track in the appropriate direction to a distance depending on the depth of water and the rate of the cross-tide. The sinking speed of concrete sinkers is 2 m/sec, and that of cast-iron sinkers 4 m/sec. (Figs 1 - 4 and 1 - 5).

(2) When laying buoys while sweeping, the buoy-layer's task should be facilitated by the OTC giving station-keeping indications in terms of distances and bearings relative to the ship astern of which she is to lay the buoys (whether this is the guide or the wing ship). The OTC should take measures to ensure that the buoy-layer's task is not impeded by the sweeping gear of these ships.

b. Other Tasks

Buoy-layers may also be assigned the following tasks:

(1) Point buoys, i.e. keep station near buoy in order to make it easier for the guide to steer the correct course.

(2) Check positions of buoys and adjust them if necessary.

(3) Act as 'dan runner' if this method of navigation is used.

(4) Act as mine disposal vessel to sink/detonate swept moored mines floating on the surface or destroy marked ground mines.

(5) Keep radar/visual watch on sweepers for gaps in coverage.

(6) Maintain a buoy-laying diagram on which every line of buoys is drawn, together with any distinguishing marks of individual buoys. Track coverage and runs per track should also be recorded.

(7) Act as recovery vessel for man overboard.

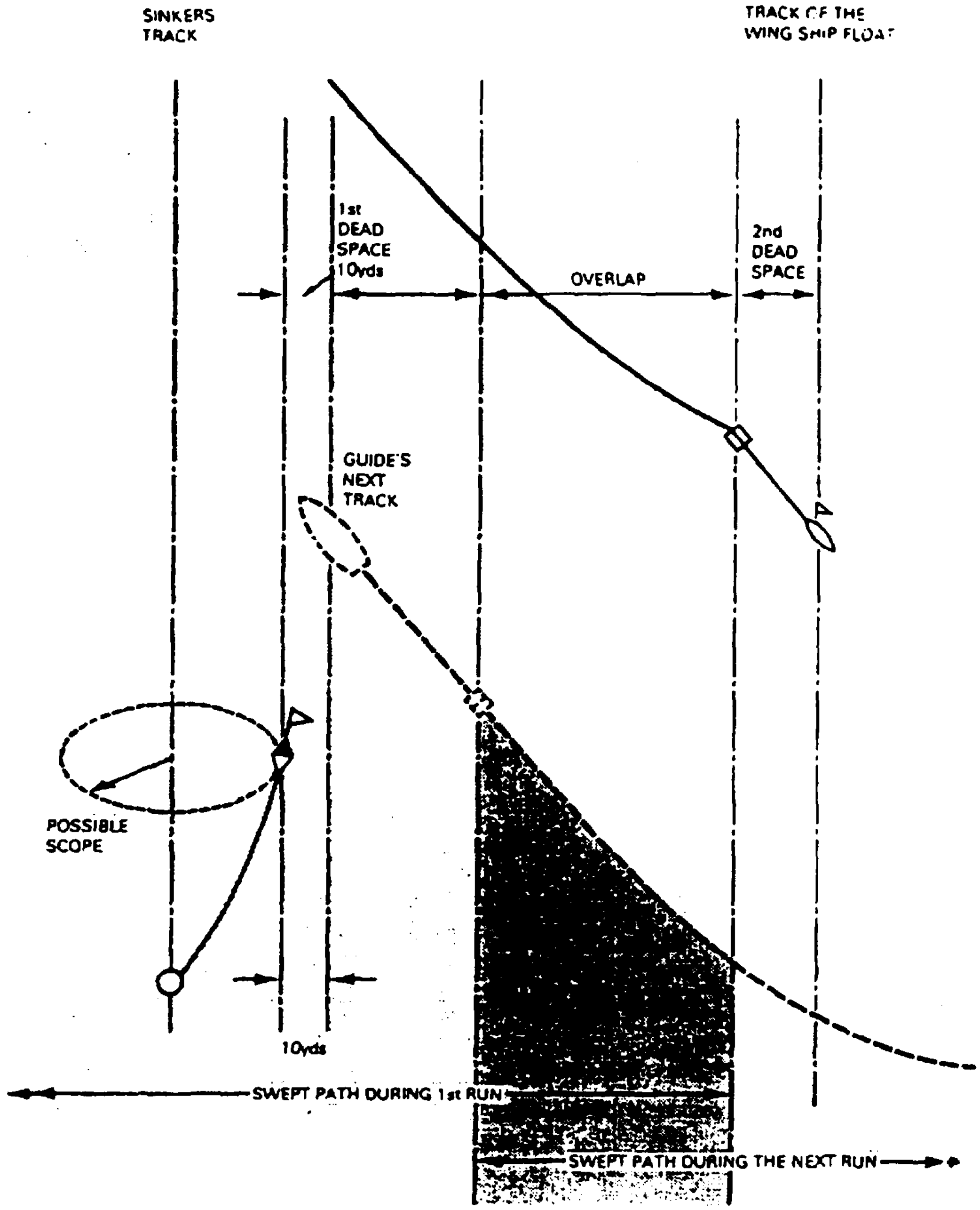


fig 1-4. Determination of Line of sinkers in relation to track of Wing Ship Float (Buoy-Laying during MCM)

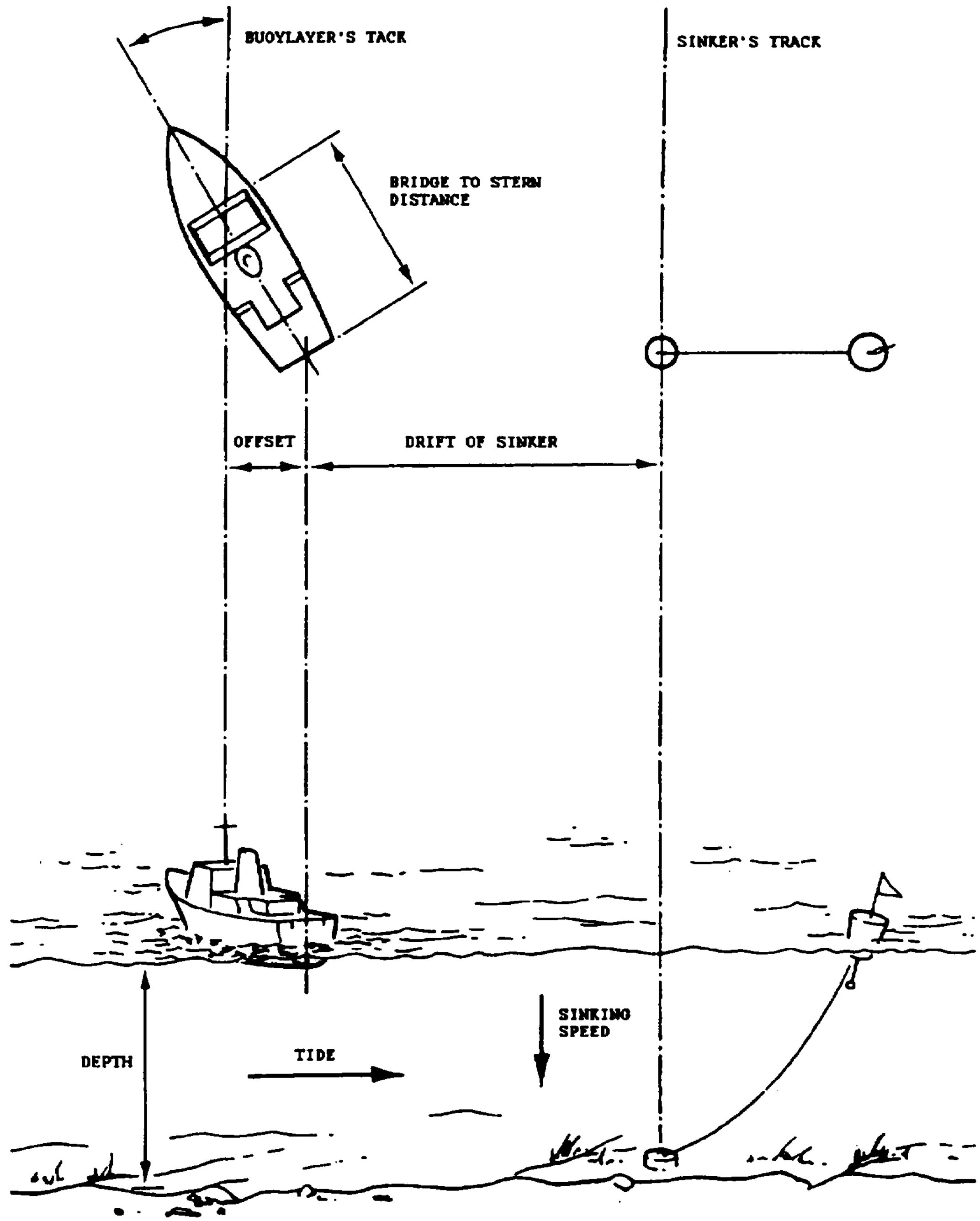


fig 1-5. Buoy-Layer's Track

0164. NUMBERING OF BUOY LINES AND BUOYS

a. A uniform system of numbering buoy lines and buoys is a requirement particularly applicable to an operation where various groups of MCMVs work in the same area.

b. Buoy lines are numbered in the same way as MCM tracks (see para 0160b and Fig 1-3).

c. Each buoy in a line has to be lettered. The lettering starts at that end of the MCM operation area where the MCMVs enter the area for the first run.

0165 - 0169. SPARE

SECTION 7

FORMATIONS AND TURNS IN MINESWEEPING

0170. GENERAL

a. The problems peculiar to sweepers are those concerned with taking up formation while veering sweeps, 180° track-turns, changes in track-course and changes in formation.

b. The characteristics of the numerous types of minesweepers and their sweeping equipment vary and are subject to change. In addition, the development of navigational aids introduces new manoeuvring methods from time to time.

c. **Preliminary MCM formations** are formations in which the execution of various phases, such as taking up formation, station-keeping, veering/streaming sweeps, and speed changes lead into the ordered MCM formations.

d. For these reasons the instructions in Chapters 2 and 3 do not include precise details of the manoeuvres described. They contain the signal to order the manoeuvres. The detailed procedures applicable to each type of sweeper are to be given in national publications and are based on the general principles in Chapters 2 and 3.

e. A summary of standard MCM Formations is shown in Figure 1 - 6.

0171. TRACK-COURSE AND SPEED

In accordance with EXTAC 1000, and supplemented as necessary, the following course and speed definitions are applicable in MCM:

a. Track Course

The true course of the track.

b. Operational Speed

The highest speed at which ships will be required to proceed during a particular operation or during a stated period.

c. Signalled Speed

The speed in knots at which the guide has been ordered to proceed. In MCM the signalled speed is reached by using the normal number of revolutions/value of pitch for the ordered speed, adjusting as necessary for foul bottom and damage, but not adjusting for sweep-gear streamed.

d. Sweeping Speed

The SPEED THROUGH THE WATER (STW), which is the result of the effect of the gear on the signalled speed.

e. Stationing Speed

A speed slower than operational speed, specified for reasons of fuel economy. Stationing speed should be ordered or included in the operation order.

f. Optimum MCM Speed

The speed made good over the ground for a given set of conditions which provides the greatest sweeping/hunting rate.

g. Minimum Towing Speed

The slowest speed through the water at which it is possible to proceed with towed gear.

h. Maximum Towing Speed

The speed through the water which may not be exceeded without causing damage to the gear or the towing vehicle.

i. Standard Speeds

All speeds to be ordered during MCM operations, including speeds through the water whilst streaming, recovering and turning, for each type of MCM gear in use (if not indicated in the relevant chapters of this EXTAC) are to be signalled by the OTC.

(1) When independent methods are used in mechanical sweeping operations, sweeping speed is 1 knot more than the speed indicated for mechanical sweeping formations.

(2) Particular conditions (weather, current) may cause the OTC to alter the standard speeds as given in the appropriate tables.

0172. GUIDE

In addition to the responsibilities of the formation guide as listed in EXTAC 1000, the guide in MCM Formations assumes the following duties:

a. Responsibility for the navigation along the ordered sweeping track sequence.

b. Providing ships in the formation with information which may make stationkeeping easier, in particular details of mean course steered to maintain the track.

c. Directing the execution of the component manoeuvres given in standard methods ordered by the OTC.

0173. DIVISIONS AND SUBDIVISIONS

When subdivisions are referred to in the diagrams of instructions for formations and turns, they refer to subdivisions in the particular formation and do not necessarily bear any relation to the administrative organization of the squadron.

0174. CHOICE OF FORMATION

a. The following factors may govern the choice of formation made by the OTC:

(1) Problems of station keeping.

(2) Area required and available for track-turns.

(3) Time required for track-turns.

(4) Required sweep depth for mechanical minesweeping formations.

b. It is sometimes preferable to use a disposition consisting of two manoeuvrable formations rather than a single formation which may be difficult to manoeuvre.

0175. TAKING UP FORMATION

a. The standard minesweeping formations are lettered, the letter being followed as necessary by PORT or STBD to indicate the side of the formations. The standard formations are illustrated in Table 1 - 4.

b. In the formation diagrams in Chapter 2 the numbers represent station numbers unless otherwise indicated. Lateral separation may be changed by signal. In minesweeping operations, ships may automatically change their station numbers.

c. Ships normally take up formation and stream sweeps in consecutive phases as described in the following chapters. Further details such as speeds and distances, which are peculiar to the types of MCMVs, are to be given in national publications.

d. In some circumstances it may be desirable to stream sweeps before taking up formation, e.g. when approaching a minefield along a narrow channel. In such cases suitable formations are taken up and sweeps streamed using signals from EXTAC 1000.

e. Formations are normally to be taken up relative to the signalled track course (L CORPEN), but it may be preferable in certain circumstances to take up a formation relative to another course. In this case, the signal P FORM 3 has to be used:
"... the direction of the formation axis is ..."

TYPE OF SWEEP	FORM H	METHOD OF TAKING UP FORMATIONS	STANDARD TRACK-TURN METHOD (STTM)	STATION-KEEPING METHOD
TEAM	E	E	2	Line of bearing/distance
OROPESA	G	G	39	Method 6 - overlap and longitudinal separation
	I	I	39	Method 5 - overlap and angle from track course Method 6 - overlap and longitudinal separation
INFLUENCE		M21 M22 M23	Independent	Independent navigation

Table 1 - 4. Relation Between Formations, STTM and station Keeping

0176. REARRANGING THE FORMATION

a. A formation may have to be rearranged either after a modification of the lateral separation of tracks or in the event of a breakdown of one or more minesweepers.

b. A modification of the lateral separation of tracks will be signalled by the guide's hoisting the corresponding formation signal.

c. Breakdown procedures are as indicated in Chapters 2 and 3.

0177. ALTERING COURSE DURING A RUN

a. The course followed by a formation on a track may have to be altered:

(1) to follow a line of MCM buoys which is not straight;

(2) because of a bend in the channel.

b. For temporary alterations from the track-course (e.g. because the buoy line is not straight, or to sweep round obstructions), the temporary course may be signalled by the use of G CORPEN or K CORPEN depending on whether course through the water or course over the ground is required. Sweepers in the formation adjust station accordingly.

c. Alterations of course for bends in the channel are normally carried out by wheeling, but the use of signals CORPEN J or CORPEN K may be more convenient in certain circumstances. As these courses are 'through the water', L CORPEN should be signalled as soon as possible after completion of the alteration.

d. When ships are in column or line-of-bearing formation they should begin to take up their new stations individually when they reach the turns in their tracks.

e. When ships are in line-abreast formation the manoeuvre is made by wheeling.

f. When ships are in multiple-line-abreast formation, manoeuvring is carried out by successive wheeling of lines, each line manoeuvring by order of its own guide.

g. Necessary alterations of speed will be signalled by the guide, using appropriate speed signals.

0178. TRACK-TURNS

a. Turns at the end of runs are normally carried out in accordance with the instructions for the standard track-turn methods (STTMs) in Chapters 2 and 3 amplified by national publications.

b. The STTMs are numbered in accordance with the lists in Table 1 - 4.

c. STTMs are ordered by signal, as follows (see also EXTAC 1000.)

CORPEN L PORT (STBD) ... (3 numerals) DESIG (2 numerals)

"Alter course to port (or starboard) to new track course ... in accordance with standard track turn method number...."

d. The STTM diagrams show the course over the ground. Allowance must therefore be made for wind and cross-tide.

e. In some circumstances it may be impossible to use the STTMs provided. In such cases, the OTC should order track-turns using suitable signals from EXTAC 1000.

f. **Altering Course by 360°.** As no STTMs are provided for altering course by 360° to enable a track to be swept in the same direction as before, normal manoeuvring signals, or two successive 180° STTMs, should be used.

g. **Ship Numbers after a Track-turn**

After a track-turn stations kept by ships in the formation may be different from those kept before turning. Ships automatically take the number of the station they are assigned in the new formation.

0179. RECOVERING THE SWEEPS

Sweepers normally manoeuvre independently when recovering the sweeps.

CHAPTER 2

MECHANICAL MINESWEEPING

SECTION 1

MECHANICAL SWEEPS

0201. GENERAL

a. Mechanical sweeping includes all the techniques of sweeping aimed to cut the mine mooring to remove the mines from the area, or to detonate the mines by direct action on the mine mooring cables (cutting), the mine cases (trawling), or the mine firing mechanisms (antenna or snagline mines).

b. When sweeping shallow contact mines (other than antenna or snagline mines) the factors involved in the determination of the degree of risk to the sweeper are the depth, height and dip of the mines, and the draught of the sweeper.

c. When sweeping antenna or snagline mines, the degree of risk depends on the same factors and also on the type of sweep used (only appropriate special sweeps are safe). If a standard sweep is used against any contact mine (other than antenna or snagline), there is always a danger area because a mine may explode either on contact with the kite or on any other part of the sweep. When sweeping influence mines the safety of the sweeper may depend on the degaussing, silencing, or other self protective measures adopted. Consideration must be given to attempting to sweep the moorings of moored antenna or snagline mines rather than to use a sweep designed to actuate their firing mechanisms.

0202. TYPES OF SWEEPS

a. Moored mines are swept by towing a wire horizontally through the water at a suitable depth. The standard sweep is the Oropesa, shown in Fig 2-1. The Oropesa sweep consists of sweep wires streamed from one or both quarters, with a kite or depressor to keep them down to a set depth astern of the ship and otters controlled by floats to spread the wires horizontally apart. Mine moorings are cut by the sawing action of the sweepwire. Serrated or square wire is used (see Fig 2-2) and cutting efficiency increases with speed. At normal sweeping speeds the sawing action of the wire may fail to cut the mine mooring; the mines are then dragged along the bottom and their moorings often part. However, mines can explode and destroy the sweep, become free from the sweep (especially on turns), or be tangled in the sweep to jeopardize the sweeper when the sweep gear is raised. Thus sweeps are armed with cutters, generally explosive ones and static cutters at the extremities. The greater the scope of the sweep the more economic the use of the sweepers. However, scope may be limited by, for example, lack of sea-room or lack of water depth at the shore end of channels.

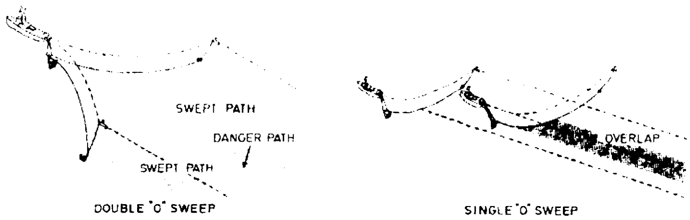


Fig 2-1. Oropesa Sweep

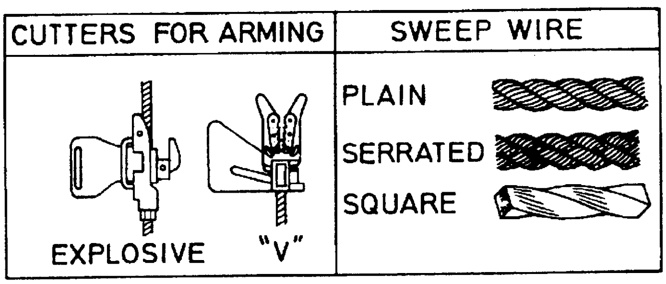


Fig 2-2. Types of Sweep Wires and Arming

b. Other mechanical sweeps include:

(1) *TEAM SWEEP*
The sweep wire is towed between two or more ships using only kites to keep the sweep down. This sweep is not so efficient at cutting as the Oropesa sweep but possesses the advantages of being capable of adjustment for depth while sweeping.

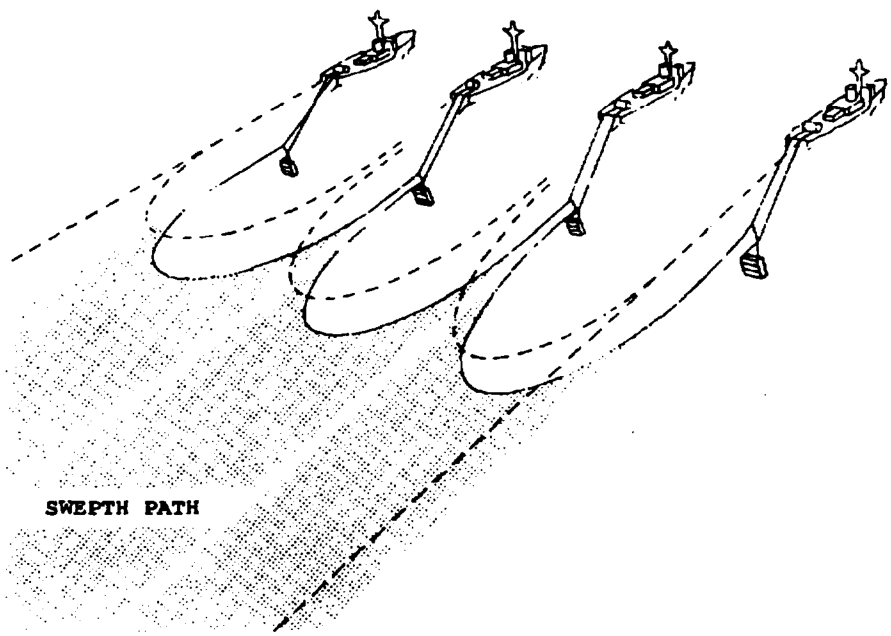


Fig 2-3. Team Sweep

(2) *THE ANTENNA SWEEP*
The Antenna Sweep may be used with either a single or multiple ship rig and is designed to ensure that the sweep wire is not brought into contact with the antenna until the mine is at a safe distance astern.

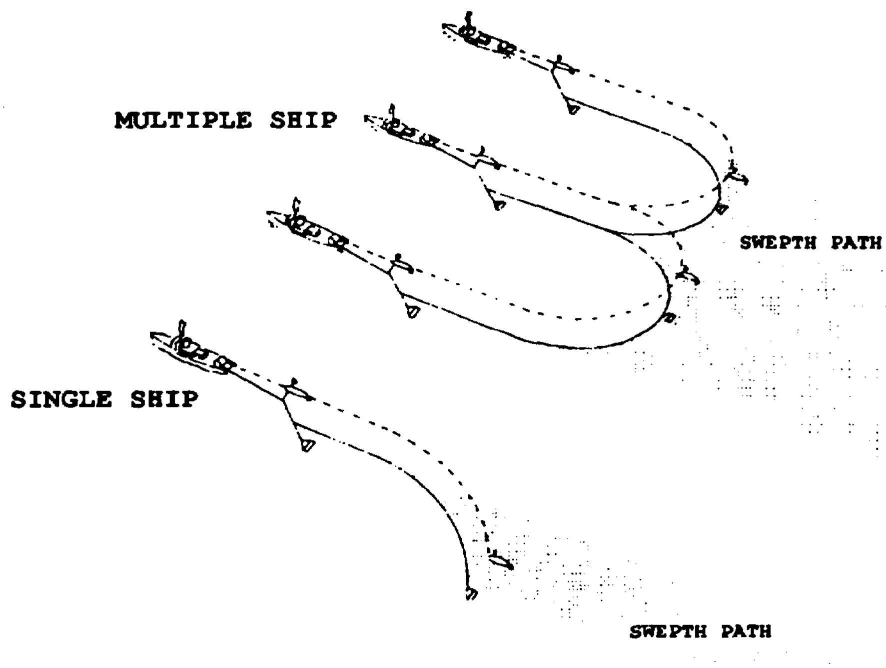


Fig 2-4. Antenna Sweep

(3) *THE SNAGLINE SWEEP*
This type of sweep is used for catching the snagline of moored mines. Sweeps are fitted with fish hooks or grips along their length and are run without kites in order to avoid detonating mines close in the wake. Helicopter wire sweeps are very useful against antenna or snagline mines.

c. Special sweep gear may be fitted or improvised as follows:

(1) *BOTTOM SWEEPS*
Bottom sweeps are two-ship sweeps used either to sweep mines close to the bottom, to sweep heavy obstructors or remove such mines and obstructors from a channel by dragging them to a safe dumping ground and releasing them. A wire bottom sweep uses a heavy sweep wire kept down by otter boards. A chain bottom sweep uses a chain for sweeping and kites for depressing.

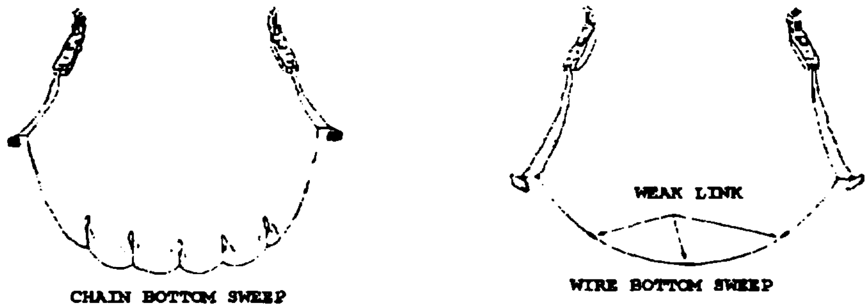


Fig 2-5. Bottom sweeps

(2) NET SWEEPS
Net sweeps are sweeps designed to collect mines and either detonate them by contact or dispose of them by dumping. They are of two types:

(a) Trawl Net
Which uses a bottom trawl to scoop up mines from the seabed.
(b) Skim Net
Which uses a surface net to collect drifting and floating mines.

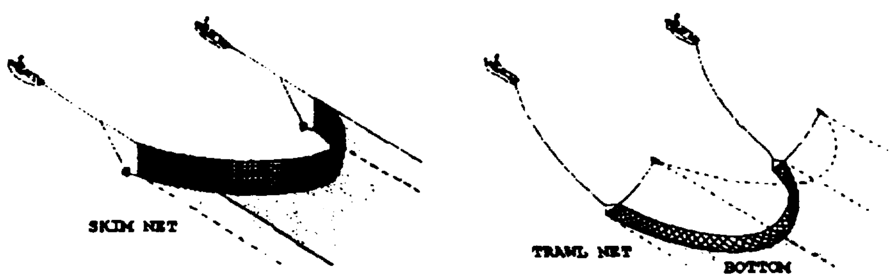


Fig 2-6. Net Sweeps

d. Gear Configuration

(1) *SURFACE SHIP GEAR CONFIGURATIONS*
Standard mechanical sweeps may be either single or double sided. Double sided sweeps should be used except when in a protected echelon formation using ship-to-float overlap, when sweeping in shallow water where it is necessary to turn away from the sweep to prevent the sweep wire from bottoming, or when the sweepers tow capability is limited to a single side.

(2) *HELICOPTER GEAR CONFIGURATIONS*
Double sided sweeps are preferred for formation and independent helicopter operations to prevent loss of a complete side to an obstructor encounter on the inboard leg, and because sweep gear handling and performance is improved. However, single sided may be preferred when the need for manoeuvring room or other operational conside-rations dictate. Factors that affect the choice of configuration include the towing capability of the aircraft resulting from atmospheric conditions and the desired tow speed.

(3) *COMBINATION SWEEPS*
The sweep speed for a combination mechanical-acoustic sweep is the smaller of either the acoustic sweep speed or the mechanical sweep speed alone. If the combination sweep speed is limited by the acoustic sweep, the scope of the mechanical sweep wire should be adjusted to the speed of the acoustic sweep (as required by national data).

0203. USE OF MECHANICAL SWEEPS

a. For any condition there is an optimum sweep towing speed for which sweeping rate is greatest. This speed is to be given in national publications for the various sweeps. The optimum towing speed is the maximum which does not produce sag or lift.

b. **Sweep depth** for standard and mechanical sweeps is the horizontal depth of the diverter and kite; this is always below the mine clearance depth. The **minimum depth** considered is that depth in the shallowest part of the segment at low tide, and the **maximum depth** is that in the deepest part of the segment at high tide.

c. The **Sweeping Rate** for a mechanical sweep is used for determining sweeping effectiveness which is a planning and evaluation criterion for MCM operations. It is found by multiplying the swept path of the sweep in question with the sweeping speed over the ground.

d. Sweep Arming. For surface ship sweeps, cutter positions on the sweep wire depend on the scope of the wire and the number of cutters used. These positions are to be given in national publications. For helicopter sweeps, cutter loading is determined by the water and mine case depth, obstructors and mine density. (See also para 0212).

0204. OBSTRUCTIONS TO MECHANICAL SWEEPS

Mechanical minesweeping may be subject to obstructions.

0205 - 0209. SPARE

SECTION 2

EXECUTION OF MECHANICAL SWEEPING OPERATIONS

0210. SPEEDS AND SCOPES

a. Scope of Sweep-wire

The scope of the sweep-wire determines the characteristic sweep path width for standard mechanical sweeps. For standard team sweeps the characteristic sweep width depends on the lateral distance between the kites of the wing sweepers making up the team sweep. For antenna team sweeps, when no kites are used, the sweep width depends only on the lateral distance between the wing sweepers. For other types of team sweeps such as bottom chain or net sweeps the swept path is based upon the type of gear being towed, the sweeper separation and the water depth.

b. It is self-evident that the greater the scope, the more economical is the use of the sweepers. It is however not always possible to choose great scopes, for geographical and topographical reasons such as lack of sea-room or water depth at the shore end of channels.

c. Sweep speeds are given in national publications and are related to the scope of the sweep wire and the speed through the water which gives negligible sag or lift.

0211. SWEEP DEPTH

a. Sweep Depths

Unless otherwise ordered, sweepers use the settings giving the maximum depth compatible with the general situation (depths, segmentation, turning areas, capacities of the sweeps etc). The choice of the settings and of segmentation is normally the responsibility of the OTC. However, when the tasking authority specifies a sweeping depth, it must be considered as a depth and the OTC has to convert it into settings, taking into account tidal range.

b. Sag and Lift

The sweep towing speed, the scope of sweep wire and the amount of arming determine the amount of sag and lift present in the sweep wire of the standard moored sweeps and deep sweeps. Sag and lift are both undesirable because sag increases the possibility of snagging the gear on the bottom, and lift increases the chance of passing above the mine or being defeated by a cutter type of obstructor. By choosing the speed and scope of sweep wire together for a particular arming state, sag or lift of the sweep wire can be kept to a minimum.

0212. SWEEP ARMING AND REARMING

a. Sweep Arming

(1) Sweep arming refers to the type, number and position of cutters attached to the sweep wire.

(2) The type of cutter depends on the type and size of the mine mooring to be severed.

(3) The maximum number of cutters depends on the type of cutter and the type of sweep gear.

(4) The number of cutters required for a particular operation depends on the density of the minefield and the depth of the sweep below the clearance depth. That is, the closer the sweep depth is to the clearance depth, or the denser the minefield, the larger the number of cutters required. Detailed instructions for determining the type and number of cutters required for arming a mechanical sweep against known or assumed mine types are to be contained in national publications.

b. Types of Cutters and their Characteristics

Two basic types of cutters are used, mechanical and explosive. Characteristics of mechanical and explosive cutters, and the maximum number of cutters per side of sweep for the various sweeps and cutter types, are to be given in national publications.

c. Choice of Cutters

(1) Both single and double Oropesa sweeps are usually armed with explosive cutters (except anti-snagline mine sweeps which are fitted with grips or static cutters). The nature of the minefield, the strength of the currents, the speed over the ground of the sweepers and the ability of the sweeps, are the factors affecting the choice between static and explosive cutters. Static cutters are ineffective at slow speeds. At speeds of less than eight knots explosive cutters should always be used.

(2) For helicopter sweeps, cutter loading is determined by the water and mine case depth, obstructors,and mine density.

d. Rearming

(1) When mechanical cutters are used, the cutters remain fixed throughout the operation and are not replaced except for those that become defective. However, when explosive cutters are used, each mooring which is severed reduces the available explosive cutter shots. Consequently, after a number of shots have been expended, the sweep must be rearmed. Since rearming takes time, this must be considered as a factor in reducing both the time available for actual sweeping and the overall sweeping rate.

(2) When sweeping in formation using standard station-keeping methods, a determination is made regarding the number of shots to be fired by the formation as a whole before rearming. This number is obtained by multiplying the number of ships in the formation by the number of shots for rearming of a single sweeper. Once this number has been fired by the formation as a whole, each sweep in the formation is to be rearmed, assuming that each sweeper fires approximately the same number of shots. However, if one sweeper in a formation fires its individual total number of allowable shots, then this sweeper should rearm, preferable at the end of the track. The remaining sweepers continue to sweep. In addition, consideration should be given to rearming all sweepers at the end of the track when the number of shots already fired is close to the number designated for rearming.

(3) The number of mines sighted on the surface during a sweeping operation can be used to estimate the number of explosive cutters fired. Upon recovery of the sweep, cutters are examined to determine the total actually fired. If the number of shots fired is greater than the number of mines sighted, the difference may be due to misfiring, firing by obstructors or firing on the bottom. In any case, the assumption should be made that some mines were missed, with a corresponding reduction in the characteristic cutting probability. Several alternatives exist for handling this problem:

(a) Rearm more frequently than indicated by sighted swept mines, in order to maintain the desired probability of cutting.

(b) Accept a lower probability during the operation, as determined by using the number of shots fired.

(c) Adjust the sweep to keep it further off the bottom.

0213. COUNTERING OBSTRUCTORS

a. The most effective measures for countering anti-sweep devices are to set the sweep depth as deep as possible, and to use heavy arming so as to cut obstructor moorings before the sweep wire comes into contact with the obstructor case. If sweep gear is destroyed despite these measures, it may indicate that obstructors and anti-sweep devices are located considerably below the mine case. The sweep depth then should be adjusted to pass above the obstructor but below the mine. The higher towing speed and lightweight gear towed by helicopters make them more vulnerable by obstructors.

b. The best-known anti-sweep devices and their countermeasures are:

(1) DELAYED RELEASE MINES
To counter these, exploratory or clearance sweeping should be repeated as frequently as necessary. As far as possible the passage of important convoys should be immediately preceded by the execution of a mechanical stage.

(2) BOUQUET MINES
Mechanical stages should be repeated until a blank run is achieved.

(3) DEVICE DETONATING THE MINE WHEN ITS MOORINGS ARE CUT OR NO LONGER SUBJECT TO A PULLING FORCE
Cutters should not be fitted within 100 yards from the sweeper. Great care should be taken when recovering sweeps.

(4) SPROCKETS, STATIC CUTTERS, GRAPNELS FITTED ON MOORINGS, CHAIN MOORINGS, OBSTRUCTORS
Use heavy arming and sweep at maximum depth. In the case of chain moorings and obstructors resort may have to be made to bottom sweeps.

(5) SENSITIVE TUBING
Sweep at greatest possible depth.

c. Minehunters and divers can be helpful against anti-sweeping devices.

0214. SWEEP PATH

a. Conventional wire sweeps

The sweep paths are given in national publications in relation to angle E (see fig. 2-18) and length of wire streamed. In the case of an unfavourable cross-tide, sweeping with a single Oropesa should not be carried out with an unfavourable angle

E of more than 6° for MSO, 10° for MSCs, and 8° for MSIs. The additional overlap required with greater values of angle E would make sweeping unprofitable. The cross-tide offsets the sweep path relative to the sweeper's track. National publications provide information to make allowance for this effect.

b. Team sweeps

The sweep path is assumed to be independent of drift and is equal to the distance apart of ships. In a cross-tide, the sweep path will be offset; the value of the offset in relation to the depth settings is given in national publications.

0215. CHOICE OF SWEEPING METHOD

a. The choice of the mechanical sweeping formation or disposition depends primarily on:

(1) THE RISK FROM MOORED CONTACT MINES will be a function of the choice of formation, for example:

(a) Independent sweeping.

$$\text{Risk}_1 = \frac{\text{Beam width of sweeper}}{\text{Swept path}}$$

(b) Protected Echelon Formation

$$\text{Risk}_2 = \frac{\text{Beam width of first sweeper}}{\text{Formation swept path}}$$

(c) Unprotected Echelon Formation

$$\text{Risk}_3 = \frac{\text{Sum of beam widths of sweepers}}{\text{Formation swept path}}$$

(d) Thus when using the same number of sweepers with the same gear we will have: $R_2 < R_1 < R_3$

(2) THE TYPE OF MINESWEEPING OPERATION is dictated by the orders of the command. The following are the main mechanical operations:

(a) Exploratory sweeping (which aims at establishing the presence or absence of mines in a given area or channel).

(b) Clearance sweeping (which aims at higher percentage coverage, normally achieved by obtaining a 'blank run' in a final check sweep).

b. When independent methods are used a flexible distance between sweepers can be laid down so as to facilitate turning or to avoid the necessity for sweepers to pass in a channel or to make easier the destruction of mines by the appointed ship.

c. The relation between MCM-risk directives and mechanical sweeping methods is shown in table 2-1.

DIRECTIVE	FORMATION METHOD		INDEPENDENT METHOD	
	EXPLORATORY	CLEARANCE	EXPLORATORY	CLEARANCE
A	MCM Formation G must be used	Formation G should be used. If it is certain that all mines are below MCMVs draught, other formations can be used	Not used	Not normally used, unless it is certain that mines are below MCMVs draught
B	Formation I, can be rapidly changed to Formation G when cutting a mine.	Formation G or I according to the degree of safety required and time allowed.	Can be used. Double 'O' sweep.	Can be used. Double 'O' sweep.
C	Formation I	Formation I	Can be used. Double 'O' sweep.	Can be used. Double 'O' sweep.

Table 2-1. MCM directives and mechanical sweeping methods

0216. PRECURSOR OPERATIONS (REDUCTION OF RISK)

a. General

Moored mines dangerous to the sweepers include very shallow contact mines, snagline mines, and mines fitted with grappling devices, as well as mines rising to the surface after they have been swept. However, the minefield may also include ground mines. Although the low magnetic signature of the sweeper, her size and slow speed, normally ensure her safety from magnetic or pressure ground mines, she remains vulnerable to acoustic mines and very sensitive magnetic mines.

b. Tactical considerations

(1) If acoustic mines are expected to be present, precursor sweeping should preferably be conducted by helicopters before sweepers enter the area. If helicopters are not available, the most silent sweeper should be tasked.

(2) If acoustic mines are not expected, mechanical precursor sweeping should preferably be conducted before attempting conventional or team sweeping. The mechanical sweeping helicopter may, in this case, be of great value.

(3) When only conventional sweepers are available, their safety can be improved by taking the following measures:

(a) Choose track-course policies that place the guide in swept waters.

(b) Whenever possible, take advantage of the fact that a mine dips in strong current.

(c) If shallow-moored mines are suspected, use MCM Formation G.

(d) Sweepers should preferably sweep at high tide and downstream.

0217. EXPLORATORY SWEEPING OPERATIONS

a. Mechanical exploratory sweeping may be carried out by either independent or formation sweeping. The choice of method will depend upon the risk to which the MCMV may be subjected. Conventional wire sweep is normally carried out. However, team sweep can be used in particular cases. Sweeps are armed, preferably as heavily as possible where conventional wire sweep is carried out and, in most cases, the depth of the sweep is as deep as possible.

b. Percentage clearance and/or effort should be calculated in accordance with chapter 8.

c. When safety of the MCMV is of primary consideration, an independent sweeper or a protected echelon formation (Formation G) is to be used.

d. When a degree of risk to the MCMV must be accepted and balanced against the accomplishment of the task:

(1) Ships in formation should use Formation I, which can be rapidly changed into Formation G.

(2) In independent exploratory sweeping both wires are streamed. Normally one run per track will suffice.

e. The tasking authority will end the exploratory operation either:

(1) When the channel/area/route has been covered to the extent ordered, irrespective of whether or not mines have been found, or

(2) When the first mine is swept.

0218. CLEARANCE MECHANICAL SWEEPING OPERATIONS

a. Mechanical clearance sweeping may be carried out by either independent or formation sweeping.

b. 96% clearance is initially required. If the number of swept mines is important, possibly the sweeping effort will be increased and a higher percentage clearance will be required. It will be kept in mind that calculated percentages are reasonably true only so far as the assumptions are verified and the cutters work properly.

c. The use of independent methods allows the minesweepers to operate at a greater speed than they would in formation. Independent methods are particularly recommended:

(1) when only a small number of sweepers are available,

(2) when there are acute bends in the channel, or

(3) when the turning areas are restricted.

d. When sweeping moored contact mines, and the safety of the MCMVs is paramount, independent sweeping is not usually used unless it is certain that the mine cases are at a depth greater than the draughts of the MCMVs. When the risk to the MCMVs is less critical, independent methods may be used.

e. Independent method

(1) NAVIGATION
Ships navigate independently, maintaining a longitudinal separation as indicated by the OTC. The track to be followed by any sweep is obtained by making allowances for the physical shape of the sweep (in the case of asymmetrical sweeps) and for cross-tide, to ensure that the sweep, rather than the ship, remains on the track.

(2) TRACK SPACING
Considerations and calculations of the track spacing are given in chapter 8. It must be noted that the track spacing depends on Angle E (see fig. 2-18).

(3) RUN TOTE
For independant mechanical sweeping the run tote (see para 0137) becomes particulary important and has to be filled in.

f. Formation Method

When clearance sweeping in formation using mechanical sweeps against moored contact mines, a clear run indicates with a high probability that all mines are swept (this is true only if B equals or approaches 1). It should also be noted that against a moored contact mine, a protected echelon formation does not necessarily ensure safety of the MCMV, as floating mines may still pose a danger.

0219. MINE DISPOSAL

When a moored mine is swept, it will normally rise to the surface and thus pose a threat to the shipping.To eliminate the risk from these mines, the following methods may be used :

a. Dragging the mines into an area where they do no longer pose a threat to the shipping, and later destroy them.

b. Applying Explosive Ordnance Disposal (EOD) procedures by specially trained personnel.

c. Sinking the floating mines by use of gunfire.

0220. DESTRUCTION OF FLOATING AND DRIFTING MINES

a. When making a decision on the best method in use, the tactical situation, the MCM risk directive in force and the relative safety and expediency of each method must be considered.

b. Generally, EOD is the preferred method to eliminate the risk from floating or drifting mines, especially when it is important to ensure the mine does not continue to pose a threat after sinking. EOD should be employed when seastate is suitable and the tactical situation permits.

c. The use of gunfire is generally not recommended for the following reasons:

(1) If sunk in shallow water, a mine case may pose a threat to vessels fishing, anchoring, or dredging in the area.

(2) There is a chance that such a mine will wash ashore following a storm.

(3) If a mine is not totally sunk by gunfire/small arms, but retains some buoyancy, it could continue to drift, partially or fully submerged at some unknown depth, and continue to be a threat.

d. With gunfire/small arms fire from a vessel or a helicopter, there is risk (about one in seven) that the mine may detonate rather than sink. For this reason, surface vessels should remain at the maximum range from the mine that affords a high percentage of hits with the minimum range being 100 yards. The same is true for helicopters, except that the minimum slant range should be no less than 200 yards at lowest grazing angles consistent with safe aircraft fields of fire and firing accuracy requirements.

e. The MCM commander must evaluate whether it is safe to utilize swimmers rather than attempt to sink the mine with gunfire/small arms.

f. Conning officers of surface vessels should be careful not to follow drifting mines into unswept waters or to overrun another floating/drifting mine while watching the mine that is under fire. If a mine drifts out of range into unswept waters, the destruction vessel should notify the sweepers and leave the mines for future disposal. Care should also be taken to assure that the line of fire against a floating or drifting mine does not endanger friendly forces.

0221 - 0229. Spare

SECTION 3

CONVENTIONAL WIRE SWEEPING FORMATIONS

0230. GENERAL

a. Limitations

The limitations imposed on turns with the sweeps streamed are as follows:

(1) 30° or less.
No restrictions.

(2) More than 30°.
Inner sweep must be shortened in before commencing the turn. Outer float must be kept outside ship's wake by adjusting the amount of wheel used. Depending on speed, depth of water and depth of sweeps, it may be necessary to raise kites.

b. Sweep Breakdown

(1) If two sweepers in the same formation part their sweeps at the same place, the following sweeper(s) haul(s) out towards swept waters or shorten in his/their sweeps. OTC should then endeavour to determine the causes of the partings and decide what steps to take.

(2) Care must be taken to avoid further losses of gear by fouling the parted sweeps of other ships.

c. Scope of the Sweep-wire

During streaming and recovery of single or double Oropesa sweeps and during turns, the sweeps are veered or recovered to nationally recognized standard positions. The actual length of sweep-wire which corresponds to these positions is (to be) given in national publications. These positions are:

(1) SHORT-STAY
When streaming the sweep, veering is stopped when the sweepwire is at short-stay to verify that the otter is running correctly. When streaming a double Oropesa sweep, the first side streamed (the uptide one) is kept at the short-stay position until the second one is also successfully streamed to short-stay. During recovery, both sweeps are normally recovered to the short-stay position before completing the evolution.

(2) *SHORTENED-IN*
During turns of more than 30°, the inner sweep must be recovered to a shortened-in position before commencing the turn. This shortened-in position may also be the short-stay position.

(3) *LONG-STAY*
The sweep is said to be at long-stay when it is streamed to the ordered length. This is the position and basis on which sweep paths are normally calculated.

0231. ORDERING A CONVENTIONAL WIRE SWEEP FORMATION

Before taking up a formation, the OTC:

a. orders the track-course, if other than the course steered, at the time of taking up the formation;

b. assigns ships to stations;

c. orders the distance apart of subdivisions (if applicable);

d. orders the depth to which sweeps are to be streamed;

e. orders the sweeps to be armed (if applicable);

f. orders the amount of sweep-wire to be used if other than normal;

g. orders the action to be taken in the event of partings, if other than normal.

0232. FORMATIONS AND MANOEUVRES IN CONVENTIONAL WIRE SWEEPING

MCM Formations G and I are used and may be taken up on any course. If the course deviates from the track-course by more than 30°, the OTC should take care to keep the sweep shortened in on the side towards which the formation is to alter course. Instructions on preliminary formations and station-keeping are given in national publications.

a. MCM Formation G

(1) The method of station-keeping is overlap and longitudinal separation (method 6; see Chapter 2 Section 5). National publications give the relevant instructions as well as instructions on preliminary formations.

(2) CROSS-TIDES

(a) Cross-tides have an effect on the distance and angle from track course of the next-ahead's float.

(b) Cross-tides make it necessary to offset the tracks to be followed.

b. MCM Formation I

(1) THERE ARE TWO STATION-KEEPING METHODS:

(a) Overlap and angle from track-course (method 5; see Chapter 2 Section 5); if the guide is downtide or uptide and angle E (see fig. 2-18) is less than 6°.

(b) Overlap and longitudinal separation (method 6; see Chapter 2 Section 5); if the guide is uptide and angle E is more than 6°.

(2) CROSS-TIDES

(a) Cross-tides have an effect on the distance and angle from track-course of the next-ahead's float.

(b) Cross-tides offset the centre of the sweep-path.

c. Track-turn

Only Standard Track Turn Method (STTM) No.39 (see para 0235) is used.

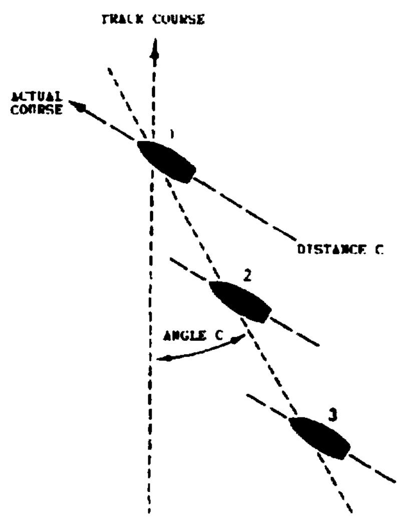
0233. MCM FORMATION G

a. Romeo Procedure

Example of preliminary MCM Formation G is shown in Fig 2-10. For an example of MCM Formation G see Fig 2-11.

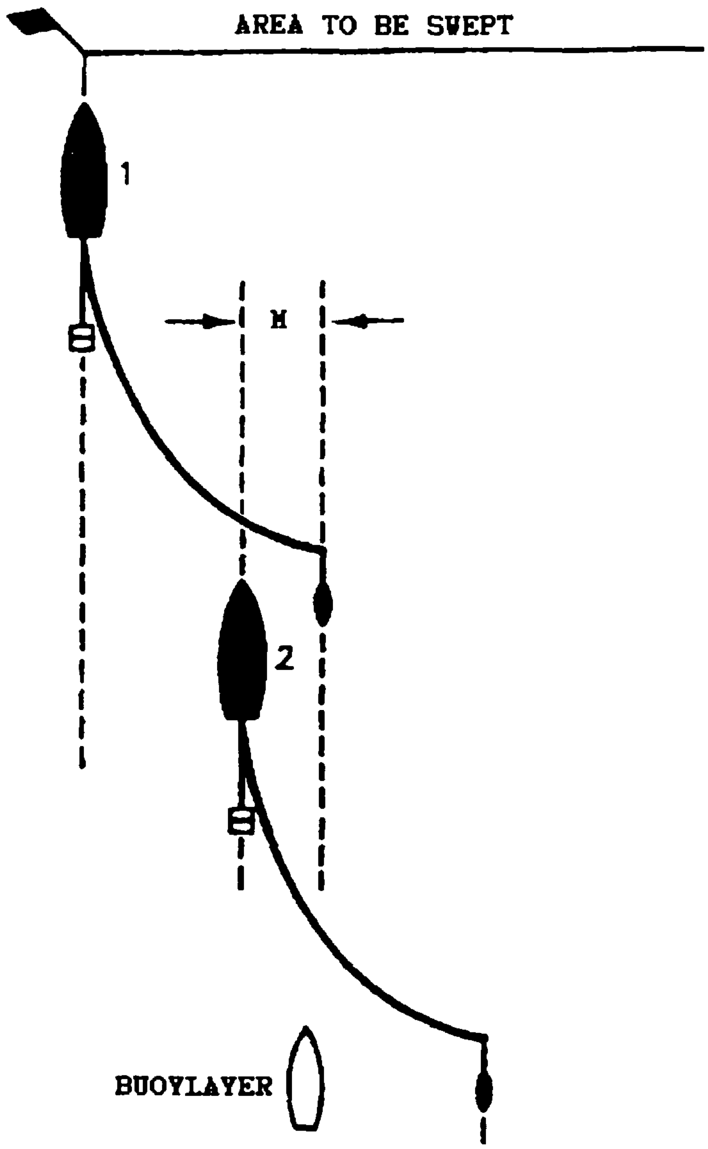
PHASE NO	SIGNAL EXECUTED BY GUIDE	ACTION TAKEN	SIGNAL ON COMPLETION
1	FORM H STBD (PORT)DESIG G	Take up preliminary formation.	R($_p$1)
2	R($_p$1)	Guide proceeds at .... knots. Sweeps are veered to short-stay.	R($_p$2)
3	R($_p$2)	Guide increases speed to...knots. Sweeps are veered to long-stay.	R($_p$3)
4	R($_p$3)	Ships take up station relative to float of next ship ahead.	R($_p$4)
5	R($_p$4)	Kites streamed.	R($_p$5)
6	R($_p$5)	Guide takes up sweeping speed when guide is at sweeping course.	-

Table 2-2. Taking up formation G



Angle C	Distance C

Fig 2-10. Example of Preliminary MCM Formation G



LENGTH OF SWEEP-WIRE BETWEEN KITE AND DIVERTER	OVERLAP TO BE MAINTAINED M

Fig 2-11. Example of MCM Formation G

0234. MCM FORMATION I

a. Romeo Procedure

Example of preliminary MCM Formation I is shown in Fig 2-12. For an example of MCM Formation I see Fig 2-13.

PHASE NO	SIGNAL EXECUTED BY GUIDE	ACTION TAKEN	SIGNAL ON COMPLETION
1	FORM H STBD (PORT) DESIG I	Take up preliminary formation.	R($_p$1)
2	R($_p$1)	Guide proceeds at ...knots. Sweeps are veered to short-stay.	R($_p$2)
3	R($_p$2)	Guide increases speed to...knots. Sweeps are veered to long-stay.	R($_p$3)
4	R($_p$3)	Ships take up station relative to float of next ship ahead.	R($_p$4)
5	R($_p$4)	Kites streamed.	R($_p$5)
6	R($_p$5)	Guide takes up sweeping speed when guide is at sweeping course.	-

Table 2-3. Taking up formation I

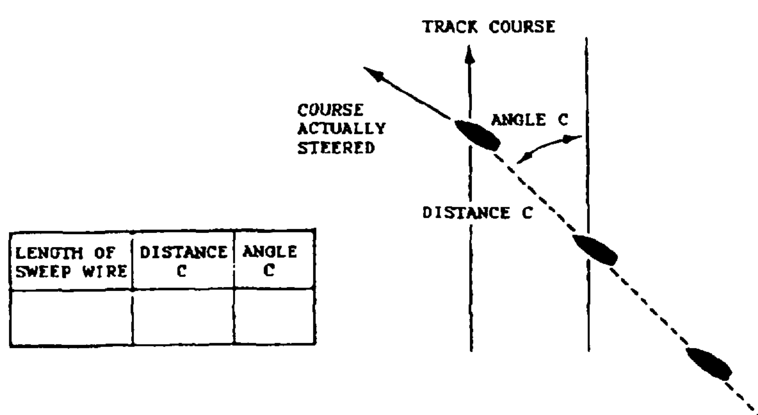
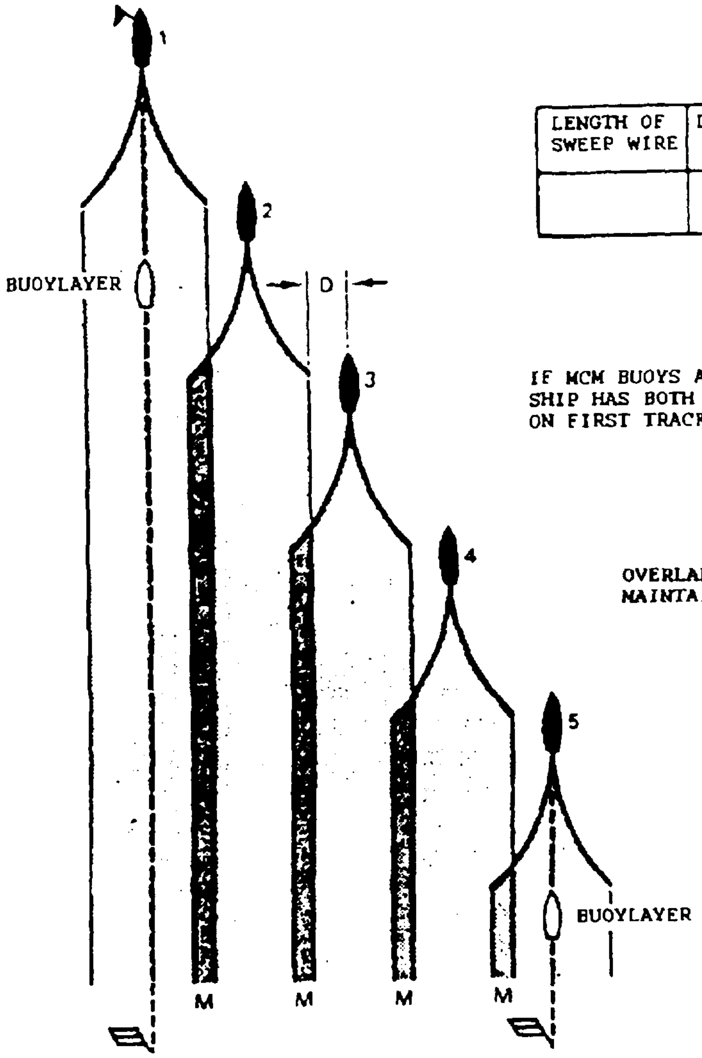


Fig 2-12. Example of Preliminary MCM Formation I



LENGTH OF SWEEP WIRE	DISTANCE D

IF MCM BUOYS ARE USED, LEADING SHIP HAS BOTH SWEEPS STREAMED ON FIRST TRACK ONLY

OVERLAP M TO BE MAINTAINED- ....yds

Fig 2-13. Example of MCM Formation I

0235. MCM FORMATION G OR I, STANDARD TRACK-TURN METHOD No 39

a. Purpose

To sweep any track in the reverse direction in either MCM Formation G or I. Same guide. (see Fig 2-15).

b. Execution

PHASE NO	SIGNAL EXECUTED BY GUIDE	ACTION TAKEN	SIGNAL ON COMPLETION
1	CORPEN L STBD/PORT__ DESIG 39__ T CORPEN__ M FORM STBD/PORT	Guide increases speed by 1 knot and alters to the throw-off course (T CORPEN). Remaining ship(s) follow in succession on clearing the track.	R($_p$1)
2	R($_p$1)SPEED__	Ships reduce to ... knots, raise kites and bring the sweep to shortened-in condition on the side of the turn. Guide increases to sweeping speed without signal when his kite is raised. Other ships conform, adjusting to remain about 200 metres astern of the next a-head's float (on the side at long stay). Guide wheels to approach course for the next track, without signal. Other ships conform in succession, adjusting the wheel to take station in the new formation. Guide can give his approach course using G CORPEN. Ships veer shortened-in sweep to long stay when on approach course.	R($_p$2)
3	R($_p$2)SPEED__	Ships reduce to ... knots and lower kites. On completion, speed may be increased to pre-serve the formation and to take station on the float of the next ahead.	R($_p$3)
4	R($_p$3)	Guide increases to sweeping speed, other ship(s) maintain formation.	

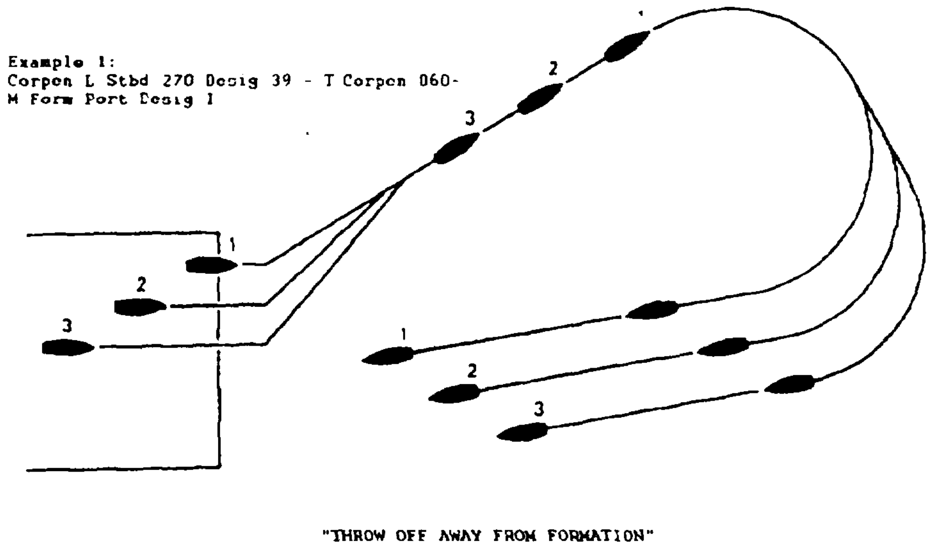
Table 2-4. Standard track-turn method No. 39

Notes

1. *CORPEN L STBD/PORT means:*
Alter course in the direction indicated to ______ in accordance with the Standard Track Turn Method number _ (preceded by desig).

2. *The throw-off course (T CORPEN) is not to be more than 30° from the track course.*

3. *When the guide is throwing-off away from the formation other ships adjust to follow in the wake of the guide. When the guide is throwing-off across the formation ships will be unable to fall-in astern when in MCM Formation I but must remain displaced and maintain a track parallel to the guide.*



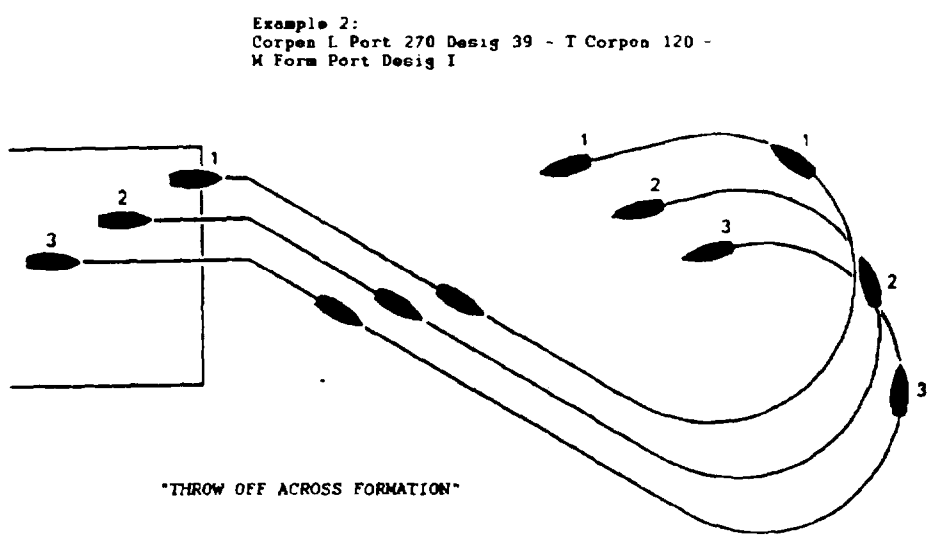


Fig 2-14. Standard Track-turn Method No 39

0236 - 0239. SPARE

SECTION 4

WIRE TEAM SWEEPING FORMATION

0240. GENERAL

a. The distance apart of ships connected together in the same team, and the longitudinal separation of the teams, are (to be) given in national publication for the different types of sweepers.

b. The overlap depends on the type of sweeper or sweep and formation. The overlap is also indicated in the national publications. Guides of teams are responsible for maintaining that overlap.

c. If mines have been cut during a passage, the sweeps must be sighted at the end of each run to make sure that they are clear before commencing the turn.

d. When there are more than two ships in a team, it is not advisable to wheel more than 90° at a time.

0241. ORDER TO TAKE UP TEAM SWEEPING FORMATION

Before taking up a team-sweeping formation, the OTC should normally:

a. order the track-course, if other than the course steered at the time of taking up the formation;

b. assign ships to stations;

c. order the distance apart of subdivisions (if applicable);

d. order the depth to which sweeps are to be streamed;

e. order the arming of sweeps if required by the method used;

f. order the amount of sweep-wire to be used if other than normal;

g. order the overlap if applicable.

0242. MCM FORMATION E

a. Taking up Formation and Manoeuvring of the Sweeps

The normal team includes two ships, but it is possible to use teams of three and four ships.

(1) *TAKING UP FORMATION E*
To take up formation, ships form column by subdivisions at 150 yards. The guides for each subdivision form into a line of bearing, 1000 yards apart. On hauling down first flag R, consorts take up station abeam of their guide on the appropriate side.

(2) *PASSING SWEEPS*
To pass the sweeps, each ship supplies half of the sweep, the two halves being connected by a shearing link. In a team of three ships, the central ship number 1 is guide for passing the sweep to port and starboard, the two wing ships numbers 2 and 3 being consorts. The guide should choose such a course as will ensure that, when the sweeps have been passed and the ships are stationed at their sweeping distance apart, the navigation guide will be on her track.

(3) When ships are sweeping in pairs, the ship closing in may use the maximum converging course and speed allowed by winch speed, bearing in mind the necessity of not allowing more sag in the sweep than the depth of water permits. In water under 50 metres, a converging course not exceeding 25° is advised.

Note
Speed should not be allowed to fall below 8 knots when the depth of the water is less than 50 metres.

b. Romeo Procedure

Examples of preliminary MCM Formation E (Fig 2-15) and MCM Formation E (Fig 2-16) are shown on the next two pages.

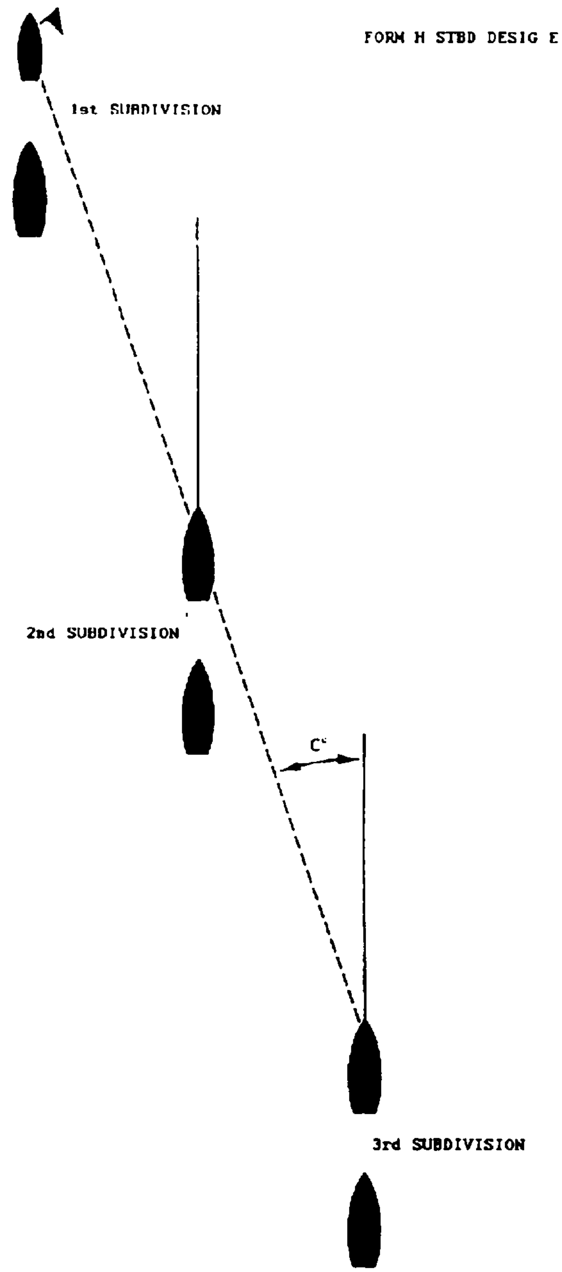
(1) PROCEDURES :

PHASE NO	SIGNAL EXECUTED BY GUIDE	ACTION TAKEN	SIGNAL ON COMPLETION
1	FORM H STBD/PORT DESIG E	Take up preliminary formation to STBD/PORT 20 metres (2C yards) apart, guide to proceed at streaming speed.	R($_p$1)
2	R($_p$1)	Pass sweeps. Then consort ship open to 30 metres (30 yards) on side indicated, both ships veering 30 metres (30 yards) wire, Attach cutter 1.	R($_p$2)
3	R($_p$2)	Consort ship open to 55 metres (60 yards). Both ships veer to 55 metres (60 yards) wire. Attach cutter 2.	R($_p$3)
4	R($_p$3)	Consort ship open to 91 metres (100 yards). Both ships veer to 91 metres 100 yards) wire. Attach cutter 3.	R($_p$4)
5	R($_p$4)	Consort ship open to 366 metres (400 yards). Both ships stream wire to 366 metres (400 yards). Use distance indicator flags if ordered by guide.	R($_p$5)
6	R($_p$5)	Down kites and stream kite wire to depth ordered.	R($_p$6)
7	R($_p$6)	Proceed at sweeping speed.	Speed ....

Table 2-5. Taking up formation E

(2) If there is an odd number of ships, the rear division is to be made up of three ships. This will cause no change in the preliminary formation.

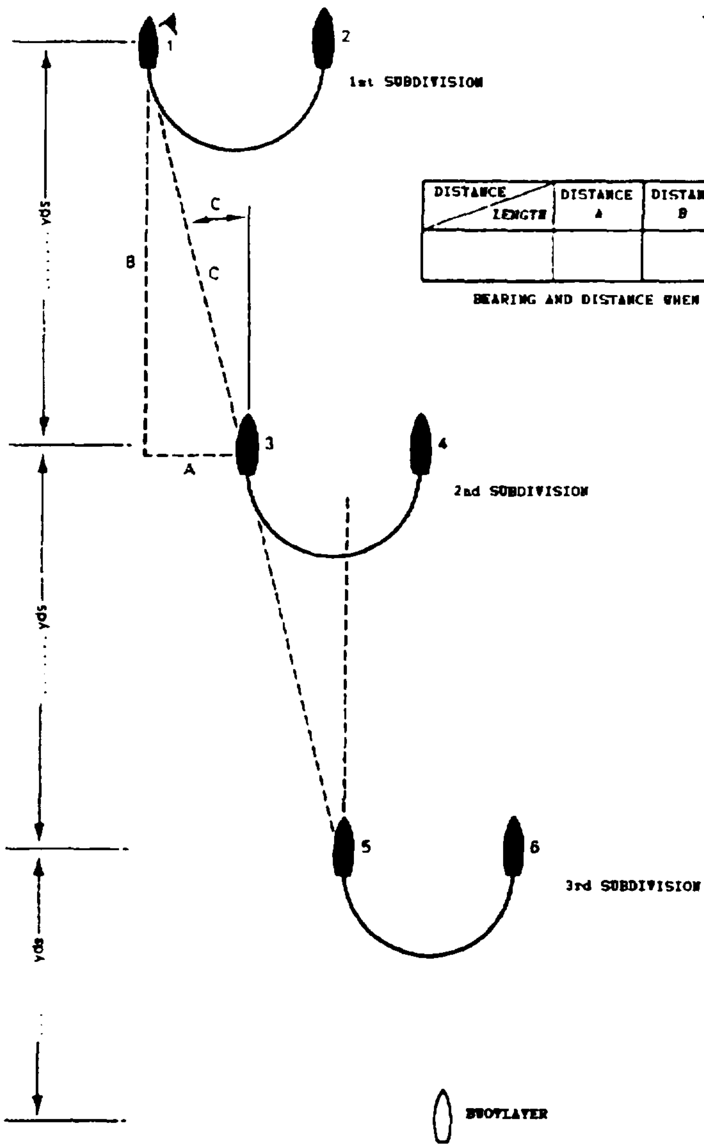
(3) Formation E can be executed with 3 ships in each subdivision if required.



Guides of subdivisions take station C° on quarter squadron guide
..................yards interval between guides.
Remaining ships from 150 yds astern of their subdivisional guides.

Fig 2-15. Example of Preliminary MCM Formation E

FORM E STBD DESIG E



DISTANCE / LENGTH	DISTANCE A	DISTANCE B	DISTANCE C	ANGLE C

BEARING AND DISTANCE WHEN IN STATION

Fig 2-16. Example of MCM Formation E

0243. TRACK TURNS

a. Procedure

PHASE NO	SIGNAL EXECUTED BY GUIDE	ACTION TAKEN	SIGNAL ON COMPLETION
1	CORPEN L STBD/PORT	Reduce speed and raise kites.	R($_p$1)
2	R($_p$1)	Outer ship becomes the new guide. Ships turn (not more than) 30° away from the next track.	R($_p$2)
3	R($_p$2)	Ships on the side towards which the turn is to be made close in 135 metres (150 yards); sweeps are hove in to 135 metres (150 yards) and sighted. Use distance indicator flags if ordered by guide.	R($_p$3)
4	R($_p$3)	Inner ship becomes the new guide. Ships turn back towards the former track course. Subdivisional guides steer so as to get into the wake of the new guide.	R($_p$4)
5	R($_p$4)	Subdivisions separately wheel (not more than) 90° in the direction indicated.	R($_p$5)
6	R($_p$5)	Subdivisions separately wheel (not more than) 120° in the direction indicated.	R($_p$6)
7	R($_p$6)	Wing ships open to 366 metres (400 yards) from their subdivisional guides. Veer sweeps to 366 m (400 yards) use distance indicator flags if ordered by OTC.	R($_p$7)
8	R($_p$7)	Subdivisional guides alter course (not more than 30° back to the new track course as requisite.	R($_p$8)
9	R($_p$8)	Down kites and stream kitewire to depth ordered.	R($_p$9)
10	R($_p$9)	Proceed at sweeping speed.	Speed ....

Table 2-6. Track Turn Procedure

b. All signals will be executed by the guide (normally the OTC himself will be the guide).

c. The new guide will be responsible for maintaining the ordered speed and for adjusting course so as to follow the right track.

d. The guide on the next track may be different from the one on the former track.

Example: CORPEN LIMA PORT ...

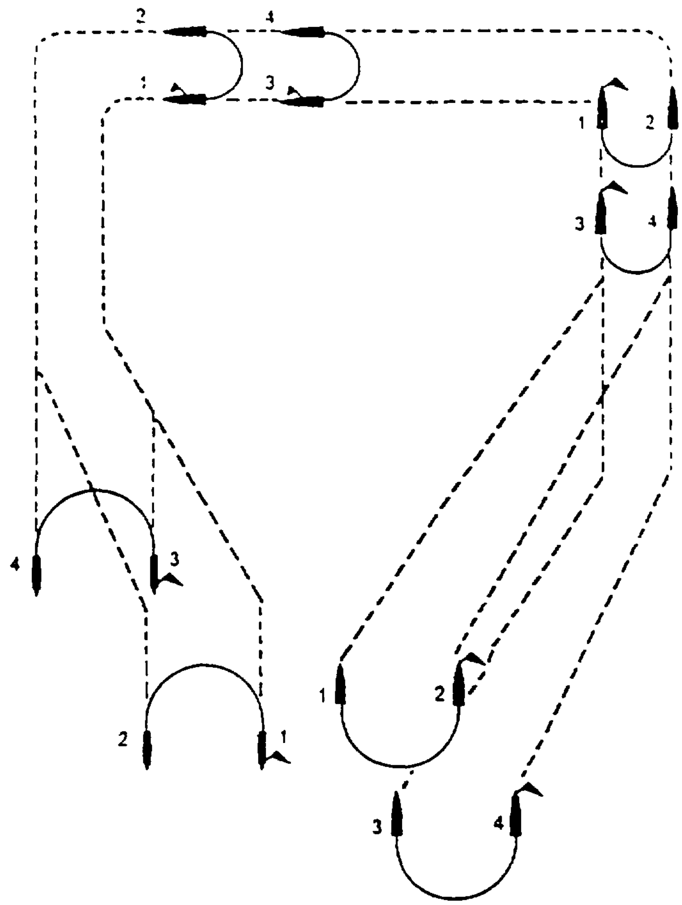


Fig. 2-17. Example of MCM Formation E - Standard Track Turn

0244 - 0249. SPARE

SECTION 5

STATION-KEEPING IN MECHANICAL FORMATION SWEEPING

0250. GENERAL

a. Definition of Stations

The stations of MCMVs in a team, a formation, or a disposition are determined successively from the guide, the following being known:

(1) TRACK COURSE

(2) LATERAL SEPARATION OF TRACKS

(3) LONGITUDINAL SEPARATION OF MCMVs

(4) STATIONING OF SWEEPERS
This is shown in the team, formation or disposition diagram. Every MCMV must, when taking up formation, occupy the station shown on the diagram indicated by the number allocated.

Note
This section has been written for minesweepers, but it is also applicable to other MCMVs with towed equipments.

b. Station-keeping

(1) As a rule, station is kept relative to a ship or float by bearing or bearing and distance. Owing to the drift, these may have to be altered while sweeping in order to maintain the prescribed coverage. The Officer of the Watch must know how to calculate these alterations. Station-keeping methods which may be adopted in a formation carrying out a given sweeping technique are governed by the following:

(a) True bearing

(b) Relative bearing

(c) Distance apart of ships

(d) Longitudinal separation

(e) Lateral separation

(f) Angle From Track-course
This is the angle between the track-course and the bearing of a reference ship or float, measured from 0 to 180 degrees from the track-course, positively to the right and negatively to the left.

negatively to the left.

(g) Corrected Relative Bearing
This is the bearing of a reference ship or float relative to the sweep and is measured from the course of the sweep through the water.

(h) Overlap
When wire sweeping in line-of-bearing formation and when the fraction of area to be covered is unity, the overlap should be greater than the maximum likely station-keeping errors.

(2) The following formulae connect these various measurements (Fig 2-17).

(a) Longitudinal Separation = lateral separation x cos (track-course bearing)

(b) Lateral separation = distance between ships x sin (track-course-true bearing),

(c) Angle from Track-course:
- true bearing - track-course
- true heading + relative bearing - track course
- relative bearing + angle F

(d) Lateral Separation = distance x sin (angle from track-course)

(e) Corrected Relative Bearing:
- relative bearing of sweeper + angle F - angle E
- angle from track-course - angle E

The measurements can thus be deduced from one another by calculation, diagram or special calculating board.

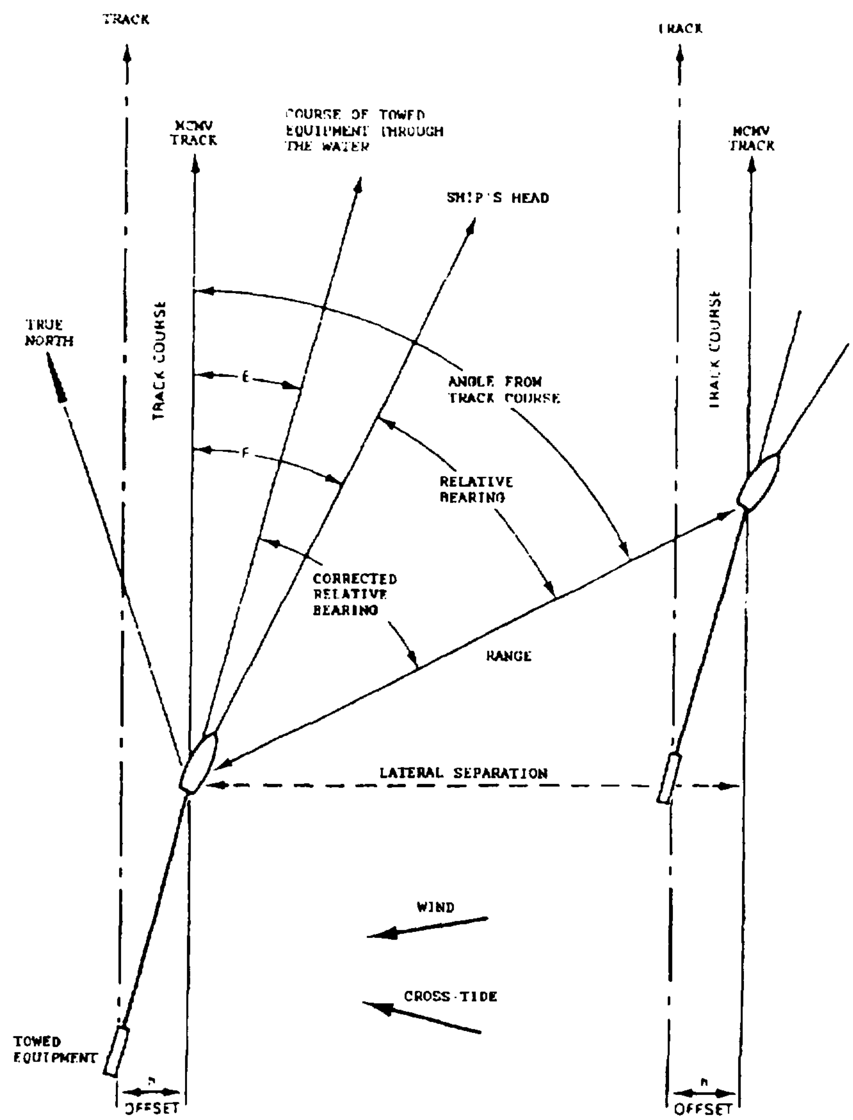


Fig 2-18. Station-Keeping Measurements

0251. STATION-KEEPING METHODS

a. Station-Keeping Methods

(1) Two different methods of station-keeping in a formation are used:

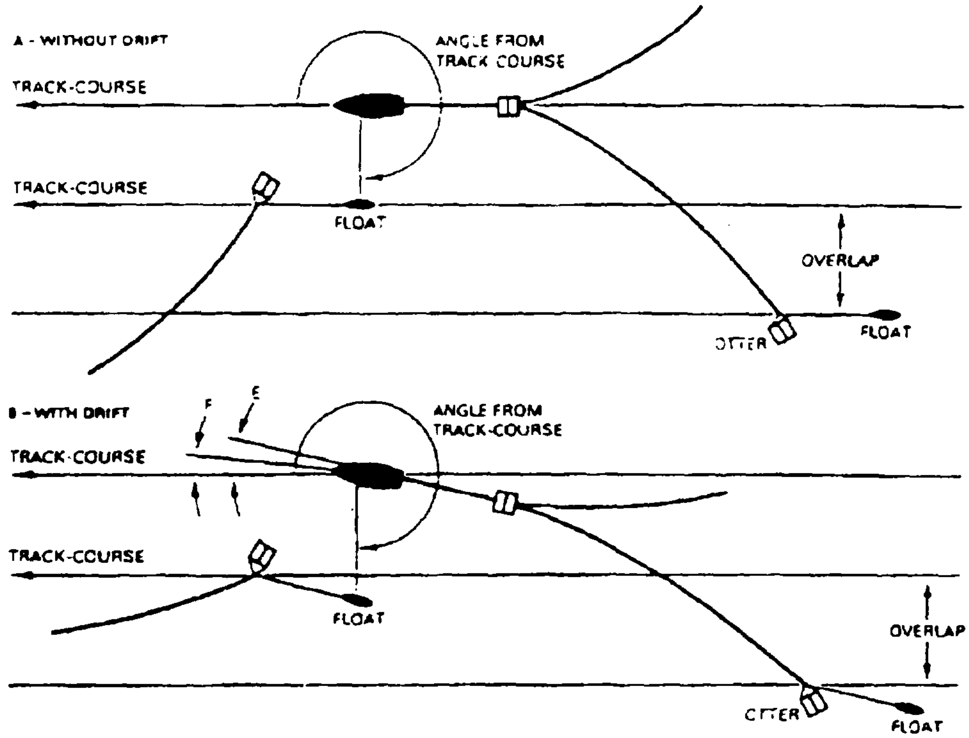
(a) Method 5
Overlap and angle from track-course (Fig 2-19). In this method, overlap and angle from track-course of a float, representing approximately the limit of the swept path, are kept constant.

Practical station-keeping measurements are:

(I) True bearing of the float = track-course + angle from track course.

(II) Distance of the float.

While true bearing remains constant, the distance of the float will change as angle E alters, and its value may be obtained from diagrams, tables or by calculation.



Station-Keeping Method 5: Overlap and Angle from Track-course

Fig 2-19. Station-keeping method 5

(b) Method 6
Overlap and longitudinal separation (Fig 2-20). In this method, overlap and longitudinal separation between the sweeper and the float of the next-ahead's sweep are kept constant. Practical station-keeping measurements are:

(I) The bearing of the float = track-course + angle from track course.

(II) Distance of the float.

Both these measurements will change as angle E alters, and their values may be obtained from diagrams, tables or by calculation. (Note that these will not be the same diagrams etc as were used for Method 5).

(2) The illustrations in Fig 2-21 gives an example of a diagram that may be used in Method 6. For practical use at sea, enlarged copies of this diagram would be required, showing angles from the float every degree and distances every 25 yards. The method of using the diagram is as follows:

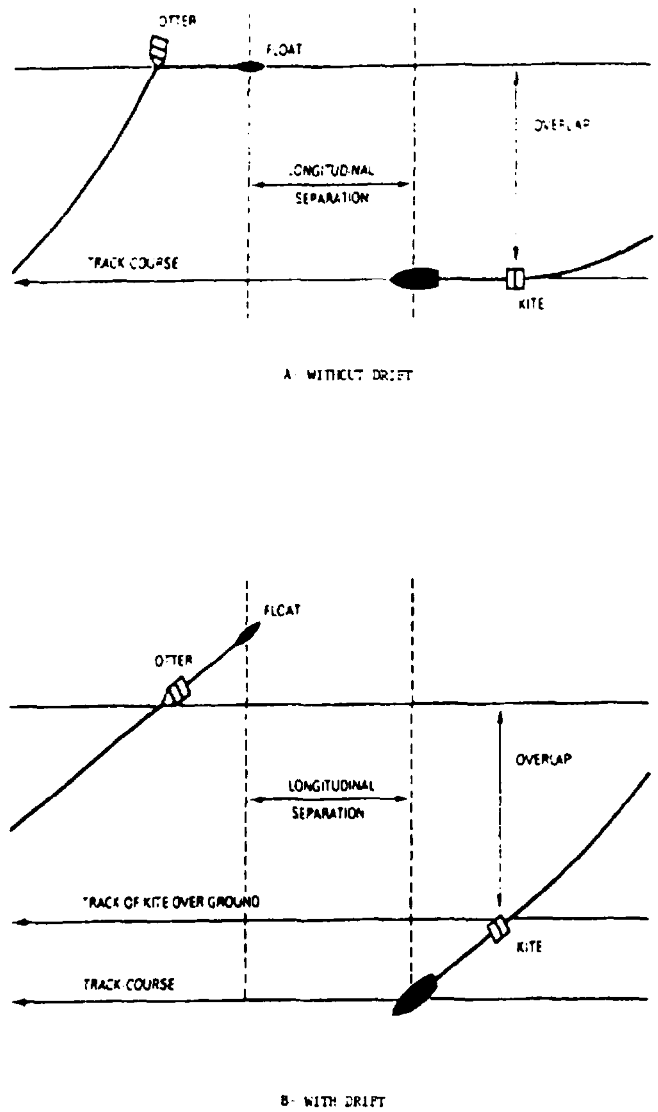
(a) Knowing the true overlap ordered, find apparent overlap by reference to the additional overlap table. Plot own ship's bridge on the diagram according to the apparent overlap and the ordered longitudinal separation between own ship and next-ahead's float (i.e. station-keeping distance astern of float). Plot next-ahead's bridge on upper part of diagram according to ordered depth of sweep and angle Echo.

(b) The following can be measured from the diagram:

(I) Bearing and distance of next-ahead's float from own bridge.

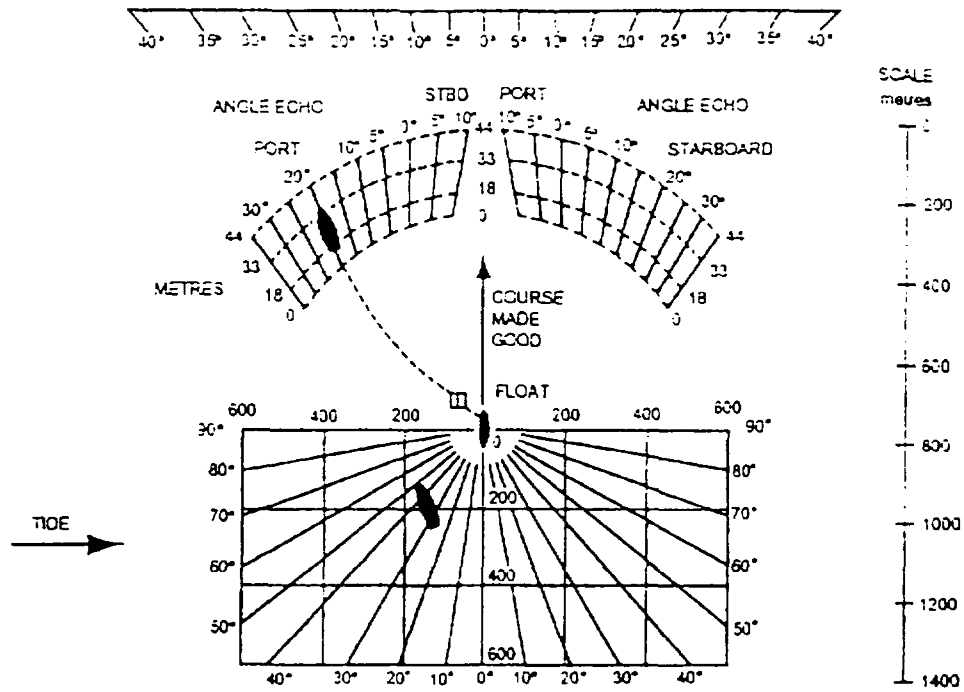
(II) Bearing and distance of next-ahead's bridge from own bridge.

To avoid having to refer back to the diagram each time angle E is altered, tables can be calculated from the diagram to give the required station-keeping measurements for all likely values of angle E for the sweep conditions chosen.



Station-Keeping Method 6: Overlap and Longitudinal Separation

Fig 2-20. Station-Keeping Method 6: Overlap and Longitudinal Separation



Example:
Formation G to starboard, depth of sweep 33 m, true overlap 73 m, angle E is 20° port station keeping distance, astern of float is 183 m, additional overlap is 54 m.

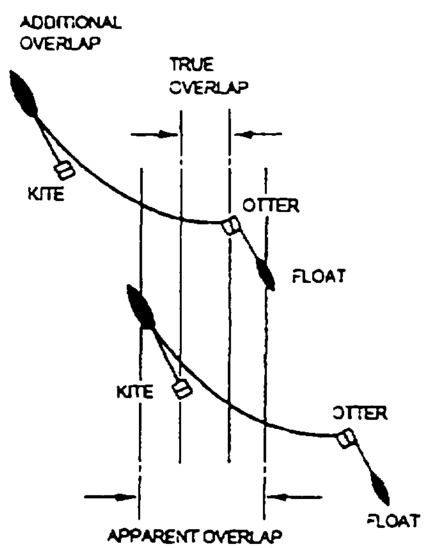


TABLE OF ADDITIONAL OVERLAP AND EFFECTIVE SPREAD IN METRES

ANGLE E°	DEPTH OF SWEEP IN METRES			EFFECTIVE SPREAD		ANGLE E
	18	33	44	Favourable	Unfavourable	
5	8	14	23	211	129	5
10	15	27	41	241	96	10
15	24	40	62	272		15
20	32	54	81	302		20
25	38	66	101	328		25
30	46	79	119	353		30
35	52	90	137	377		35

To be carried to true overlap to obtain apparent overlap as follows:

Favourable angle Echo ....ADD

Unfavourable angle Echo ....SUBTRACT

Fig 2-21. Station-Keeping in Oropesa Sweep Formation

b. Choice of Station-keeping Method

(1) MECHANICAL TEAM SWEEPING

(a) There is one recommended station-keeping method in the formation: corrected relative bearing and distance (method 1). This method has the advantage of not altering the shape of the sweep but reduces the swept path in a cross-tide. Swept path is equal to:

the distance apart of wing ships x cos E.

(b) Station-Keeping Between Teams of Sweepers is as follows :

The team guide keeps station on the outside ship nearest to him in the next team ahead.

(2) MECHANICAL SWEEPING WITH OROPESA SWEEPS

(a) MCM formation G

Line-of-bearing Formation.
100 per cent coverage within the formation is always aimed at when using this formation. Station is normally kept on the float of the next ahead using overlap and longitudinal separation (Method 6).

(b) MCM formation I

Line-of-bearing Formation.
100 per cent coverage is normally the aim when using this formation. Station is normally kept on the float of the next ahead using Method 5 or Method 6. It is better to use Method 6 when the guide is uptide of the formation and Method 5 when the guide is downtide.

0252 - 0259. SPARE

CHAPTER 3

INFLUENCE MINESWEEPING

SECTION 1

INFLUENCE SWEEPING

0301. GENERAL

Influence sweeps may be divided into three principal types, i.e. magnetic, acoustic and pressure. They can be used separately, or in combination for sweeping combination mines. Influence minesweeping is carried out by generating with the sweep the principal influence fields generated by ships in such a way that the firing mechanism is actuated by these sweep-produced fields. For present-day mines, the influence fields are effective in countering some single influence or combination influence mines even though the sweep influence patterns generated by the sweep do not always resemble those influence patterns generated by target ships. This method of countering present-day influence mines has been and is being employed principally because it generally results in very high sweeping rates in terms of square kilometres swept per hour. Against the present mine threat it would be much less efficient to generate sweep influence fields which resemble those influences generated by ships; modern mines require ship-like signatures of influence sweeps.

0302. Types of sweeps

a. Magnetic sweeps

(1) The basic types of operational magnetic sweeps are towed closed loop sweeps, electrode sweeps (two and three electrode types), solenoid sweeps and magnetised ferrous sweeps (Fig 3-1).

(a) Solenoid Sweeps
These consist of a large number of horizontal coils through which a comparatively small current is passed. The solenoid is generally incorporated in a float towed by a surface sweeper or a helicopter, or being remotely controlled.

(b) Electrode Sweeps

These generally consist of two buoyant conducting cables, an electrode being fitted at the end of each leg. The electrical circuit is completed through the sea water. A high current is passed through this circuit. These sweeps can obviously be used only where the water is sufficiently saline. Moreover, the variable conductivity of the seabed can cause considerable distortion of the magnetic field. It is therefore difficult to determine the swept path accurately and sweeper safety may be endangered. However, conductivity surveys and/or the use of a towed monitor may permit estimations of acceptable accuracy (and hence safety) to be made. Under favourable conditions of the bottom and of water salinity, the electrode fields will give a large increase in swept path compared with a loop sweep. Electrode sweeps may be straight or diverted in inverted V, Y or J shapes. Straight electrode sweeps may have a third electrode intended to reduce the horizontal component of the field produced by the sweep near the sweeper. A variant of the electrode sweep is used by a team of two sweepers, each towing a buoyant cable with an electrode at its end. The circuit is completed by a conductor running between the two ships.

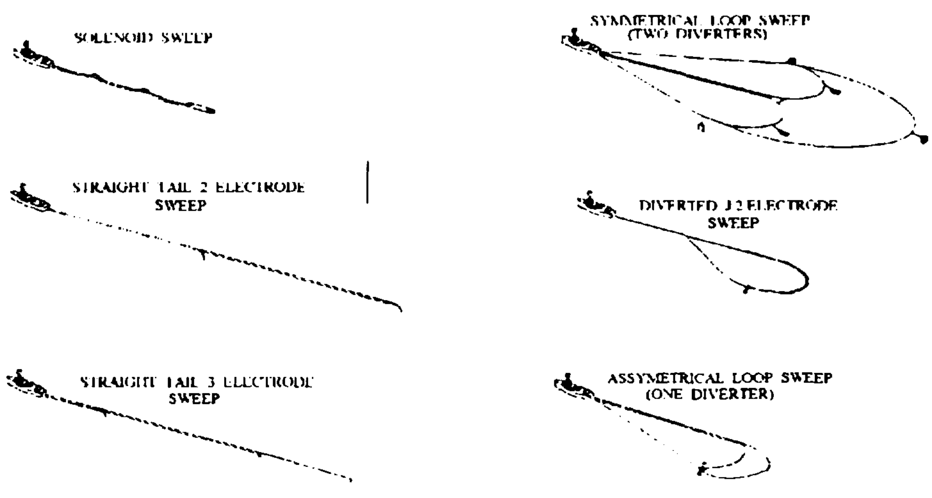


Fig 3-1. Magnetic sweeps

(c) Loop Sweeps
These consist of a conducting cable, usually buoyant, loop-shaped (the loop being kept spread by use of one or two diverters) through which is passed a high current. Loop sweeps may either be symmetrical (diverter towed on each side) or asymmetrical (diverter towed on one side only). A variant of the symmetrical loop is towed by two sweepers working as a team.

(d) Permanent Magnetic Sweeps
These consist of an array of permanent magnets which may be used to sweep magnetic influence mines. They generally have the same limitations as solenoid sweeps.

(2) Magnetic sweeps suffer from the disadvantage that, if sufficient current is passed through the cables to give a good swept path, very sensitive mines may be fired inside the damage area of the sweeper. If the current is reduced to give safety to the sweeper, the swept path is also reduced and the time taken to sweep an area is somewhat increased. The safety of the sweeper is given consideration in the choice of sweeping technique. Table 3-1 below compares the different types of magnetic sweeps.

TYPE OF SWEEP	EFFECTIVENESS		ENVIRONMENT	REMARKS
	Vertical Component Mines	Horizontal Component Mines		
Electrode-Straight tail	Yes	Less than vertical component	Depth and Conductivity	Large Fields under sweeper without security electrode. Easy to manoeuvre
Electrode-Diverted	Yes	Yes	Depth and Conductivity	Large Fields under sweeper without security electrode.
Closed Loop	Yes	Yes	Depth	Effectiveness more predictable than electrode sweeps.
Solenoid and permanent magnet	Yes	Yes	Depth	Effectiveness more predictable than electrode sweeps.

Table 3-1. Comparison of different types of magnetic sweeps

b. Acoustic Sweeps

(1) Mines can be made to actuate on the sound output of a ship which lies between approximately 2 Hz and 100,000 Hz. The variable nature of propagation of sound in water makes it necessary to limit the sound output of the sweep so that mines will not be actuated within the damage area of the sweeper. The combination of position of tow of the sweep and its sound output with regard to both frequency and intensity, affect sweeper safety, thus reduced output is sometimes desirable. A means of controlling sweep output is therefore very desirable.

(2) Operational acoustic sweeps consist of the acoustic explosive type, the vibrating hammer-bar type, the opposed-oscillating-piston displacement type, the cavitating type, the hammer-bar type, and the acoustic loud-speaker. Some ASW-lures could be used as acoustic sweeps.

(3) Acoustic sweeps can also be characterised by steady output, pulsed output, modulated output, or controlled variable output. Further more they can be categorised by their frequency ranges :

(a) Low Frequency (LF)
Sweep of which the prominent output range is up to 30 Hz.

(b) Medium Frequency (MF)/Audio Frequency (AF)
Sweep of which the prominent output is between 30 and 15,000 Hz.

(c) Wide Band Range
Sweep of which the output can cover LF and MF/AF bands.

(d) Narrow Band Range
Sweep of which the output can be restricted to a narrow band and a single frequency.

c. Combined Influence Sweeping

(1) Combined influence sweeping is the process of carrying out different sweeping techniques concurrently in order to run off ship counts or detonate combined influence mines by the production of influences likely to actuate the firing mechanism of these mines. Combined sweeping requires as full a knowledge as possible of the characteristics of mines to be swept and, in particular, of the sequence and timing of the various influences required. Various techniques may be carried out simultaneously by one sweeper or by a team of sweepers using one technique. Mines may require that appropriate

looks for both or all influences be received with definite time relationships and sweeps must be regulated accordingly. Examples of combined influence sweeping are:

(a) Sweeping Magnetic/Acoustic/Pressure Combined Mines
It is sometimes possible to take advantage of the pressure effect of a swell of a suitable period to sweep such mines using magnetic/acoustic sweeping techniques.

(b) Sweeping Combined Magnetic/Acoustic Mines without Overlap
To clear such mines, it will generally be necessary for the mines to receive both influences simultaneously. The acoustic sweep must therefore be sufficiently close to the centre of the magnetic sweep. Both sweeps should he towed simultaneously at long stay.

0303. USE OF MAGNETIC SWEEPS

a. Sweeping Speed

Two principal considerations determine sweeper speed when sweeping magnetic mines. These are that the safety of the sweeper increases as its speed increases and the sweeping rate is not necessarily maximum at the highest towing speed. For a given set of conditions, there is an optimum sweep towing speed (over the ground) for which the sweeping rate is greatest. When the indicated optimum towing speed over the ground exceeds the maximum towing speed through the water, the latter speed becomes the sweeping speed. To maintain the optimum towing speed over the ground, corrections should be made for the effects of the water current.
When the safety of the MCMV is of paramount importance, consideration should be given to the mine types to be countered and to the appropriate selection of the MCM pattern. If only magnetic mines are present in the minefield, the maximum possible towing speed through the water will be the safest sweeping speed. However, if other mines are present, for example acoustic or pressure mines, the overall danger to the MCMV may be increased by the use of maximum speed. When full current is used, the safety is provided by keeping the MCMV in swept waters. The optimum towing speed over the ground should be used as the sweeping speed.

b. Constant Output

Magnetic sweeping gear using constant current output is different from pulsing equipment as there is no change in the produced magnetic field. The only changes seen from the mine are occurring from the movement of the gear in the water.

c. Pulse Cycle

The pulse cycle period is the time interval between the beginning of one pulse and the next in the same direction. The pulse cycle used depends on the characteristics of the mines being swept. The sensitivity of a particular mine to one pulse cycle is not the same as its sensitivity to another, so that a variation of the pulse cycle may also vary either sweeping efficiency and/or safety of the sweeper. The necessary changes in the magnetic field required to actuate magnetic induction mines can best be produced by pulsing sweeps at intervals as the MCMV moves forward. With existing pulse distributors or controllers it is generally possible to select the wave form (square, sinusoidal, triangular, arbitray shape), the pulse length, the pulse interval (on-time plus off-time) and the polarity of four successive pulses. Pulsing also enables generators to produce peak fields larger than would be possible using their continuous power rating. To actuate a mine, consecutive pulses have to be of opposite polarity, whilst field strength may have to be varied throughout the pulse which must last sufficiently long to overcome the damping and to operate the mine relay. Control equipment is therefore fitted to enable pulses to be generated. Examples are shown in Fig 3-2.

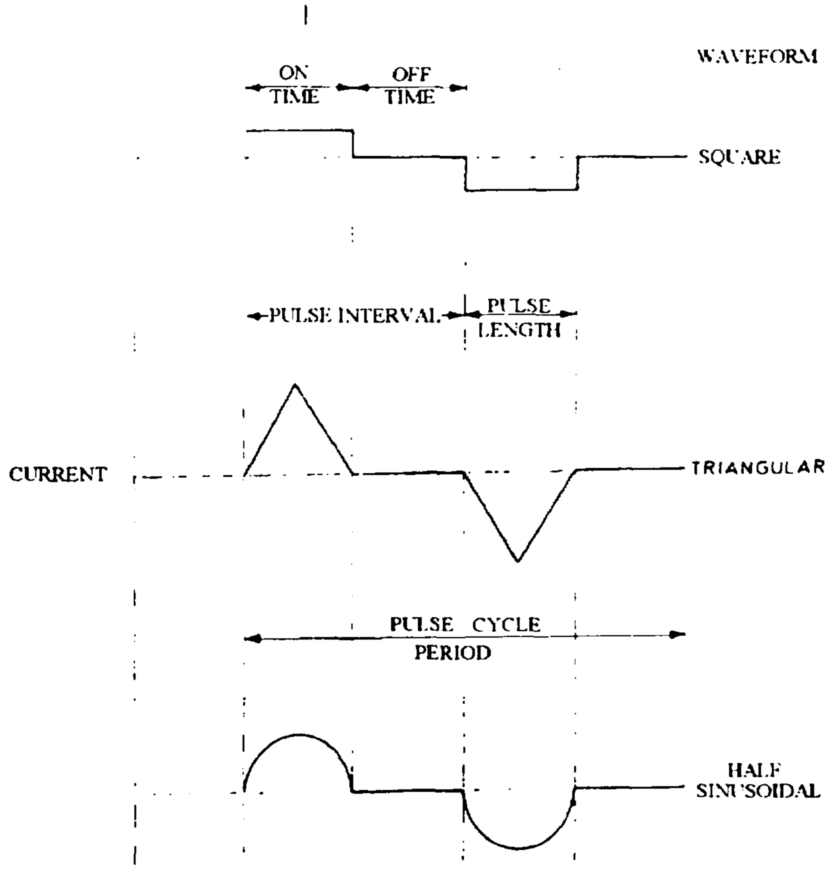


Fig 3-2. Pulse Cycles

d. The Sweep Current

The actuation parameters of a magnetic sweep increases as the sweep current is increased. In many cases, however, the maximum sweep current will impose an unacceptable risk to the MCMV. Therefore, the use of a reduced sweep current (safe current) must be considered in sweeping magnetic mines for the purpose of MCMV safety. The magnetic field produced in the damage area is a function of the field produced by the sweep and by the combination of sweeper/sweep. It consists of the sweep field directly beneath the MCMV, the MCMV constant field and the sweep generator stray field. If maximum current is used, this may result in a dangerous front (F). Using safe current, the actuation width will be reduced and the dangerous front may be zero.

e. Sweeping Actuation Level

The Sweeping Actuation Level (SAL) is the amplitude pulse height or half peak to trough in a sweeping waveform of a given character which will just cause mine actuation in the orientation of maximum mine response with respect to the mine axis. Example:

100 Nt (square wave reversed pulsing)
6 seconds ON - 3 seconds OFF

The angle between the orientation of the mine axis and the orientation of the magnetic field results, for horizontal component mines, in two values of actuation width which are, the average aggregate actuation width (W) for all possible angles and the lower aggregate actuation width (w) for the most unfavourable angles. Average aggregate actuation width is used in all types of operations except clearance. Lower aggregate actuation width is used for clearance. For a given mine and for different characteristics of the wave form, different values of SAL (amplitude) can be found. Values of SAL are given in national publications. Because of tolerances in the manufacture of mines two values are used in calculations for SAL:

(1) SAL + σ.SAL = Ho
(2) SAL - σ.SAL = -Hm

f. Sweeping Rate

For a given mine and sweep, it is possible to determine an optimum sweeping rate. The sweeping rate equals actuation width multiplied by sweeping speed over the ground (WV). Sweeping rate is used to determine sweeping effectiveness (a planning and an evaluation criterion for MCM operations).

0304. USE OF ACOUSTIC SWEEPS

a. An acoustic sweep can be fitted in, towed abeam or under, or towed astern of the ship. When the sweep is fitted in or towed abeam or under the MCMV, the sweep suffers from the disadvantage that when magnetic and acoustic sweeps are towed concurrently, the source of noise is at some distance from the centre of the magnetic field. Therefore certain combination magnetic/acoustic mines may not be swept. It also greatly increases the danger to the MCMV from certain mines. Towing the acoustic sweep at long stay gives maximum safety against coarse mines. There may be a risk from medium sensitivity mines but this is limited because the actuation width will necessarily be larger than the danger width, so that many mines will be exploded outside the damage area and because of the actual variability of mine sensitivities even among mines nominally the same. Also it is very unlikely that the propagation the same. Also it is very unlikely that the propagation conditions will be known by the enemy, so it would be almost impossible for him to ensure that a large proportion of the mines laid were capable of exploding within the damage area.

b. Whether the risk to the sweepers is greater when the sweeps are towed at long stay than it is when they are towed under the ship depends on the characteristics of the mines laid by the enemy. A sweeper towing sweeps under the ship is certainly in danger of damage from coarse and directional mines, whereas, if the sweeps are at long stay there is less probability of damage from the conventional medium sensitive mine.

c. The frequency band of a sweep is that within which it is likely to actuate mines. The sound output, apart from falling off towards the limits of the band, is not uniform and varies considerably over a range of a few Hertz.

d. The optimum sweeping speed is a compromise between the rate requirement limits of the mines and the towing speed over the ground. For a MCMV with significant sweep limitations (15 knots for example), the optimum sweeping speed is the maximum towing speed, unless the MCMV towing a controlled variable output sweep is carrying out target sweeping. In that case, the sweeping speed should be equal to the target ship speed.

e. The pulse cycle period is the time interval between the beginning of one pulse and the next similar pulse. The pulse cycle used depends on the characteristics of the mines being swept. The response of one particular mine to one pulse cycle is not the same as its response to another. Therefore, variation of the pulse cycle may lead to more, or less, efficient sweeping. The necessary changes in acoustic output required to actuate acoustic rate requirement mines can best be produced by pulsing or modulating the sweep at intervals as the MCMV moves forward. With existing pulse controllers, it is generally possible to select the build-up output time. Maximum output is only produced during high time. For each sweep mine combination an optimum pulse cycle is given.

f. For each sweep mine combination, there is a frequency band (NFB) in which most energy is transmitted from the sweep to the mine. In the NFB, the maximum Allowable Transmission Loss (ATL) is the maximum loss in sound pressure level from the sweep to the mine that permits actuation of the mine. Since the transmission loss is not exactly known and most sweeps cannot be used as controllable variable output sweeps, the acoustic sweeping parameters have only approximate values. The same applies for actuation and safety parameters of target ships.

g. When only the acoustic sweep is employed, it should be towed at long stay astern of the MCMV. When used with the guinea-pig sweep, the acoustic sweep is towed 50 yards astern of the guinea-pig. For combination sweeps, care should be taken to maintain the correct sweep configurations including the combined sweep offset.

h. The depth at which acoustic gear should be towed is given in national publications. If the water depth is so shallow that the gear is likely to drag on the bottom, it will be necessary to modify the standard towing configuration.

i. Since the acoustic propagation loss tends to increase as the sound source is brought nearer to the surface, the depth of the gear should not be reduced any more than necessary to prevent the gear from bottoming. When sweeping in waters shallower than 15 metres, the sweep depth should be equal to half of the average water depth.

0305. OBSTRUCTIONS TO INFLUENCE SWEEPING

Influence minesweeping may be subject to obstructions such as:

- The arming Delay
- The shipcounter
- The Intermittent Arming Mechanism

0306 - 0309. Spare

SECTION 2

EXECUTION OF INFLUENCE SWEEPING OPERATIONS

0310. TRACK SPACING

Considerations and calculations of the track spacing are given in chapter 8.

0311. OFF-SET DISTANCE

Off-set of the sweeper in relation to angle E in order to have the centre of the influence of the gear (or combination of gears) following the track are to be given in national publications.

0312. DISTANCE BETWEEN MCMV's

a. When influence sweepers pass close to each other or to other ships, there is a danger that the acoustic and/or magnetic output from both the influence sweeps and the ships may combine to cause an unacceptable increase of the influence levels within the damage area of the MCMV or ship. To minimize the danger of this occurring, standard safety distances are used.

b. Sweeps must be de-energized or switched off when the sweeper is at, or within the safety distance from any other ship or MCM unit.

c. Magnetic Sweeps
When only magnetic sweeps are operated, the safety distance may be equal to twice the aggregate actuation width of the sweep against the most sensitive mine of this type. If intelligence information is not available, the standard safety distance should be calculated assuming a single-look mine with a 50 nT actuation level and a sweep operating at maximum output.

d. Acoustic Sweeps
When using acoustic sweeps either alone or in combination, a standard safety distance of 1.5 nautical miles is used. This may however be reduced by the Tasking Authority in the light of intelligence information or if there is an operational requirement to do so.

0313. TRACK TURNS

Where track turns are executed in waters which may be mined, it is advisable to keep the acoustic sweeps working and the magnetic pulse stopped. In this case, it is necessary to avoid sweepers endangering each other by passing too close with their sweeps operating. Whenever possible, turns are to be conducted in such a way that sweepers do not pass each other within influence actuation width with their sweeps energized.

0314. MANOEUVRING WITH INFLUENCE SWEEP GEAR

Instructions and information concerning manoeuvring and handling of the different types of sweep gear is to be given in national publications.

0315. SWEEP BREAKDOWN

a. **When Repairs of Sweep are Beyond Ship's Capacity**
The OTC orders the MCMV concerned to leave the area or channel to be swept, trying not to hinder the other ships, and proceeding if possible through swept waters.

b. **When Repairs are Within Capacity of Ships Staff**
The OTC may order the MCMV concerned to either continue the task with the other sweeper(s) whilst taking into account the reduction in sweeping effort during the period when the sweep is inoperative or to stop the task and proceed through swept waters to a favourable area to repair the sweep.

0316. RUN TOTE

For influence minesweeping the run tote (see para 0137) becomes particularly important and has to be filled in.

0317 - 0319. SPARE

SECTION 3

INFLUENCE MINESWEEPING FORMATIONS

0320. GENERAL

This chapter deals only with independent sweeping or loose sweeping formations, i.e. MCMV's stream and navigate more or less independently, ensuring that the sweep is on the sweep track.

0321. PRELIMINARY FORMATIONS

The following formations are established to simplify the preliminary manoeuvring for independent or loose sweeping formations. Distance apart of ships may be varied by separate signal.

a. FORM H - M 21
Form column in present sequence (or sequence indicated), distance apart as ordered. When ready, stream sweeps required for next stages. Course will be adjusted by leading ship to enter track in accordance with sweeping plan. Remaining ships conform, each ship being responsible for own navigation.

b. FORM H - M 22
Ships are to act independently to pass point N (or position indicated) at intervals as ordered in order of sequence numbers (or in sequence indicated), on course to take up track in accordance with sweeping plan, with sweeps streamed.

Note
FORM H - M 22 should be executed at the same time as ordering 'stream sweeps'.

c. FORM H - M 23
Ships are to act independently and stream sweeps, reporting intended time of passing Point N (or other position indicated).

Notes
1. *Reports should be made between 40 and 20 minutes before the anticipated time of passing point N and should allow a separation of one mile at sweeping speed from any time of passing already reported by another ship.*

2. *The object of this method is to allow maximum flexibility by enabling ships to begin useful sweeping as soon as possible after streaming their gear without waiting for other ships to complete streaming.*

3. *Point N is situated on the route (centreline) 1 nautical mile off the channel entrance (see fig. 1-3).*

CHAPTER 4

MINEHUNTING

0401. GENERAL

A minehunting organisation, occasionally including support by clearance divers, is necessary because it is not efficient to counter mines containing certain types of actuating mechanism by minesweeping.

The primary usefulness of minehunting is that it allows tactics other than those available to sweepers, particularly:

(1) Defining non-mined waters.

(2) Establishing diversions.

0402. MINEHUNTING DETECTION EQUIPMENT

a. A variety of equipments and technical processes permit detection, classification and localisation of ground and/or moored mines. These different processes are at present principally based on optical and acoustic means of detection.

b. Optical Detection

Optical detection is based on the use of clearance divers, remote vehicles, aeroplanes and helicopters.

c. Ahead-looking Sonars

Ahead-looking sonars may be either hull-mounted or towed at variable depths. Their general characteristics are:

(1) They usually have two operating frequencies, one for detection purposes and the other for classification.

(2) Detection widths A are determined by the sonar beam width and the selected search pattern and vary with sonar range. Search patterns are designed to insonify the seabed and/or the water volume and are achieved by automatically training the transducer array around a centre bearing (normally the track course).

(3) Detection probability B of the sonar against bottom mines is directly related to the environmental conditions. There is a necessity for an exact definition of the B-factor and the interaction of its components for minehunting and for a more realistic assessment of their values.

(4) As a consequence trackspacing (D) is determined taking into account the following :

(a) The values of A and B.

(b) The desired percentage clearance.

(c) The standard deviation value of navigational error.(see also chapter 8).

d. Towed Side-looking Sonars

Towed side-looking sonars are high frequency and high resolution sonars. They are contained in vehicles which are towed astern or abeam by the MCMV. One or more vehicles are towed and they travel (fly) at a constant height above the seabed. Towed side-looking sonars permit general and detailed surveys as well as providing a means of surveillance and check operations. However, a detailed analysis is only possible if the precise geographical position of the towing vessel and the relative position of the towed vehicle is known.

0403. MINEHUNTING TERMINOLOGY AND PHASES

a. Detect

The action of operating minehunting sensors (acoustic, optical or magnetic) to find objects on or in the seabed which distinguish themselves from the general structure of the bottom, or to find objects floating in the water volume. Detection, by itself, does not make a distinction between objects which resemble or do not resemble a mine.

b. Classify

The action of operating minehunting equipment to investigate detected contacts with the intention of discerning those which have mine-like properties (size, shape, shadow and structure). Thus all investigated contacts are classified as follows:

(1) MINELIKE

This is a contact which, by assessment of its size, shape, shadow and structure is considered as likely to be a mine. Not all criteria must necessarily be fulfilled to classify a contact as minelike. A further distinction may be made into POSSMINE (possible mine) and/or PROBMINE (probable mine) adding a degree of probability to the conclusion MINELIKE.

(2) NONMINE

This is a contact which does not satisfy the criteria for a MINELIKE object.

c. Identify

Identification may be undertaken by divers or underwater vehicles. The contact being a CERTMINE (certain mine) or a NONMINE.

(1) DIVERS
Clearance divers embarked in MCMV with hullmounted or variable depth sonars may identify contacts and they can also be used in the disposal phase.

(2) UNDERWATER VEHICLES
In order to reduce the risk to divers underwater vehicles fitted with a TV camera or sonar imaging device may be used both for identification and disposal.

d. Locate

The term locate is a commonly used term which concerns the determination of the position of a contact detected during the searching phase. This position may be either plotted or marked.

e. Plot

The construction of a record by which the result of detection, classification and/or identification can be operationally exploited. As such, minehunting survey and reconnaissance operations express their result in the construction of a plot or chart of the area covered. Plots can be:

(1) A geographical chart or overlay.

(2) Data-processed.

(3) Bottom pictures.

(4) A suitable report.

f. Mark

To indicate the position of a contact classified MINELIKE by acoustic means, or identified CERTMINE by visual means.

g. Dispose

In general, when the intention is to eliminate the mine danger, mines are disposed of by the minehunter or by other means such as a diving vessel assisting the hunter. Mine disposal is done by countermining or mine neutralisation. For reasons of the particular tactical objective, rendering safe, recovery and removal of mines are not included in the general term DISPOSE.

(1) COUNTERMINE
Place and detonate an explosive charge sufficiently close to a mine to ensure the sympathetic detonation of the mine main explosive charge.

(2) NEUTRALISE
To render a mine, by external means, permanently incapable of firing on passage of a ship or sweep. The mine case may remain virtually intact. Also, the mine may remain dangerous to handle.

0404. BOTTOM CONDITIONS AND UNDETECTABLE MINES

a. Bottom conditions may be summarised as bottom composition, profile and clutter.

b. A certain fraction of the mines present in an area may be undetectable because of bottom conditions.

0405. MINEHUNTING CONDITIONS AND PROCEDURES

a. It is important to stress that assessments of minehunting conditions are frequently peculiar to a given type of sonar and are not necessarily the same when other types of sonar are used.

b. On arrival in the area, if the minehunting conditions are bad for his sonar, the Commanding Officer should signal those conditions to his next highest authority.

0406. LOCATION OF CONTACTS IN MINEHUNTING

a. The advantages of precise location are obvious. It allows action to be taken, with economy and certainty, whenever it is not possible or practical to investigate a detected contact immediately.

b. It is essential that on all occasions minehunters should be careful to locate the contacts obtained as accurately as possible and that the synthesised information collected be recorded in a form which can be used by other minehunters.

0407. BOTTOM CHARACTERISTICS

a. Composition

The composition of the seabed may be mud, sand or rock, or various combinations of these. Minehunting sonar performance will be degraded in areas of rock bottoms and wherever there is a mine burial in a mud or sand bottom.

b. Profile

Smooth flat bottoms pose no significant problems to mine-hunting equipment. However, if the bottom contains tall obstructions, deep holes, or sharply sloping regions, the effectiveness of minehunting gear may be greatly reduced. Mines may be hidden in holes or behind rocks, and towed gear may snag on underwater obstacles. Such areas should be noted and marked on a chart. Bottom profiles are grouped into three types, defined as follows:

(1) SMOOTH
Very few craters, gullies, or ridges which would conceal or partially obscure mine-sized targets (5 per cent or less of the area), or sand ripples 15 cm (6 inches) high or less.

(2) MODERATELY ROUGH
Considerable number of craters, gullies, ridges, seaweed patches or 15-30 cm (6-12 inch) sand ripples which may conceal or partially obscure mine-sized targets (5 to 15 per cent of the area).

(3) ROUGH
Extensive areas where craters, gullies, ridges, large sand ripples etc would conceal mine-sized targets (over 15 per cent of the area).

0408. BOTTOM CLASSIFICATION

Bottom types characterize the seabed and are defined in Tables 4-1 and 4-2 below:

TYPE	BOTTOM DESCRIPTION	MINEHUNTING CONDITIONS
A	Stable and smooth flat bottom. Ripples less than 15cm deep and/or moderate mine burial possible but never exceeding 15 cm.	Good area for mine-hunting. Covering the area once with parallel tracks is normally sufficient.
B	Rather stable and smooth but uneven bottom. Holes, bumps, ridges and folds up to 30cm and/or mine burial possible but never exceeding 30 cm.	Minehunting is possible. Minehunting effectiveness may be improved by covering the area twice with tracks at 90° to each other.
C	Rough bottom. Holes, bumps, ridges and folds exceeding 30cm and/or a lot of seaweed. Mine burial likely (exceeding 30 cm) but never complete.	Minehunting is difficult. Covering the area twice at 90° angle is necessary but, even so, the detection probability will be low. Minehunters, as far as possible, are not to be asked in type C areas.
D	Mines are likely to be hidden completely (see causes in Table 4-2).	Effective minehunting is not possible.

Table 4-1. Bottom Types

CAUSE	BOTTOM TYPE
(a) By irregularities of the bottom	DR (R for rock)
(b) By seaweed	DV (V for vegetation)
(c) Owing to complete burial (mines may be buried permanently or break surface from time to time)	DB (B for burial)
(d) In deep hollows or crevasses or by cliffs	DH (H for hollow)
(e) For other reasons	DZ

Table 4-2. Causes for Hidden Mines

CHAPTER 5

CLEARANCE DIVING OPERATIONS

0501. INTRODUCTION

a. This chapter discusses the operations carried out by clearance divers who operate as specialist groups and who as such are not normally attached to or borne by minehunters.

b. Clearance diving operations are ordered by the appropriate naval authority, as for minesweeping and minehunting.

c. The following instructions contain the broad principles governing the use of existing equipment and the methods applied.

0502. NEED FOR CLEARANCE DIVING

a. It is important to acknowledge the separate identity of the clearance diver team and the requirement for it, on occasion, as a self-contained MCM task unit.

b. A clearance diving organisation is necessary, because there are certain tasks which cannot be performed by minehunters or sweepers due to prevailing environmental restrictions, (such as water depth, underwater visibility, ships at anchor) or because the MCM equipment is not capable of completing special functions.

c. Clearance Diving Objectives are:

(1) Location of mines.
(2) Identification of mines.
(3) Disposal of mines.

0503. USE OF CLEARANCE DIVERS

Clearance divers are used:

a. Mainly in shallow or confined waters which are not accessible to minehunters or which prevent the effective use of the minehunting sonar. This is particularly the case in harbour areas in the vicinity of lock gates etc, and in narrow channels. In these circumstances the diving team is responsible for both finding and disposing of mines.

b. In small parts of channels or areas where the minehunters' sensors are ineffective due to environmental factors such as cliffs, coral reefs, crevices, wrecks etc.

0504. FACTORS AFFECTING CLEARANCE DIVING OPERATIONS

Clearance diving operations are influenced by a number of factors. These will affect the various stages in the planning and conduct of the operation.

a. Operational Considerations (The Task)

The operational considerations affecting the task of clearance diving operations comprise:

- The size and condition (bottom topography and composition) of the area to be searched,
- The time available to complete the task,
- The type and anticipated amount of targets to be encountered, and
- The possible disposal/rendering safe/ recovering of the mines found.

b. The clearance diving team's capabilities (The Means)

The following factors related to the capability of the clearance diving team will have to be considered:

- number of divers available for the task,
- navigational method and capability,
- available craft (dinghies),
- available equipment to fulfil the task (e.g. for disposal, for rendering safe (tools), and for recovering mines).

c. The operation will be affected by a number of limiting factors. These comprise:

(1) Physical environment:

- Weather affecting personnel on the surface,
- Seawater temperature affecting the divers,
- Tidal streams and currents,
- Water depth,
- Underwater visibility,
- Sea state affecting shallow water diving (and personnel on the surface),
- Marine life (dangerous or poisonous fish and plants),

(2) Support arrangements,

- Availability of decompression chambers,
- Medical facilities,

(3) Condition of divers,

- Physical condition of divers,
- Mental condition of divers,
- Time since last dive.

d. The above listings should not be considered as exhaustive as overall conditions may vary.

0505. NAVIGATION IN CLEARANCE DIVING OPERATIONS

a. General

(1) All clearance diving operations are characterised by a very narrow search path, sometimes not wider than the diver's span. Therefore, very great accuracy is required by clearance diving craft in both marking and navigation.

(2) If divers are operating for disposal of mines previously located, they have to know the location of mines with an accuracy which is smaller than the length of their snagline (normally 30m).

(3) Any area in which clearance divers are to operate should be marked with buoys.

b. Shore Marking

(1) In areas near coasts with no conspicuous natural landmarks, simple shore transit marks should be set up. These can be posts with flags on top placed at regular intervals.

(2) In ports, narrows, and the like, wharfs, docks and piers may be graduated. These graduations are used to mark transits (parallel or converging on a distant point). These marks enable operations to be carried out with accuracy and speed.

c. Charts, Plots and Hydrographic Information

(1) The normal navigational charts available will seldom be on a scale convenient for use in clearance diving operations. Detailed plots are required, constructed to a desired scale and gridded for easy reference.

(2) Clearance divers may use lattice charts (1/1000 to 1/10,000) on which are drawn the conspicuous shoremarks and if possible the transit lattice, or the horizontal sextant angle (HSA) or radio navigation curves. If there is no plot for a given operation, the divers should prepare a large scale diagram on which they can place the natural or artificial shoremarks to be used for triangulation.

(3) Hydrographic information. For every area in which mines are assumed to be laid, in depths as deep as 55 metres (30 fathoms), clearance divers need the following:

(a) Photocopies of draft sounding sheets used by Hydrographic Survey Officers (HSO) to draw charts.

(b) HSO charts, as detailed as possible (1/20,000 to 1/50,000).

(c) Position of rocks, wreckage, and the like, that might hinder searches.

(d) Details concerning bottom-dredging operations, deepening and filling-up operations.

(e) Main shipping routes and possible diversion routes.

(f) Bottom characteristics: nature, hardness, seaweed and so on.

(g) Current; strength and direction on the surface and on the bottom according to tide and weather conditions.

(h) Underwater visibility, according to prevailing wind and sea and the season.

d. Methods of Navigation

In their searches, divers can follow jackstays laid from boats. They can also be towed by boats. The methods of navigation of the boats are those used in hydrographic surveys, which are the best available, unless the boats are equipped with precise navigation systems.

0506. PRINCIPAL SEARCHES CARRIED OUT BY DIVERS

There are four principal ways in which divers can search for mines laying on the seabed or suspended or floating in mid-water.
These are:

- visual search
- snagline search
- search by touch
- use of hand-held active or passive acoustic or magnetic search aids.

0507. DIVING SAFETY

The safety measures to be taken by divers are a national responsibility. The OPCON Authority must therefore be provided with national regulations for the divers (time tables, directives etc).
The level of risks to divers is determined by the Risk Directive. If diving teams of different nations using different methods have to work together, detailed briefings of methods and materials used must be conducted beforehand.

0508. SPECIAL REPORTS

On first detection of an unknown mine or any other object of an unknown nature a PRETECHREP and if necessary a COMTECHREP should be drafted by the locating unit in accordance with Annex F.

0509. COMMUNICATIONS

Clearance diving teams (CDT) should have organized communications with their tasking authority and portable communications sets with frequencies allocated by the OPCON to communicate with other units.

CHAPTER 6

MW-MESSAGES

SECTION 1 - INTRODUCTION

0601. GENERAL

MCM-operations are supported by structured orders and reports. Description and examples are given below.

0602. TYPES OF ORDERS

a. **Mine countermeasures orders consist of:**

(1) *MCM OPERATION ORDERS (OPORDER).*

(2) *MCM OPERATIONS DIRECTIONS (MCMOPDIR).*

(3) *MCM TASK ORDERS.*

b. The OPORD provides basic information to all participants and is the basis for all subordinant command levels.
The format is explained in annex A.

The MCMOPDIR provides a MCM commander to promulgate intentions to subordinate commands and units.
Instructions for drafting the MCMOPDIR are in annex B.
The format is the MW124 signal in annex E.

The MCM Task Order provides specific instructions to a unit concerning his task given by his tasking authority.
Instructions for drafting the Task Order are in Annex C.
The format is the MW 125 signal in annex E.

0603. MCM REPORTS

Reports are used by all command levels to keep each other informed concerning progress and/or particularities in order to timely adapt tasks and tactics ordered.

a. Tactical level

Units being controlled by an OTC will keep him informed by MCM reports stating the progress of work detailed to them by the appropriate task orders. Reports to be sent are stated in the task order. Units also report those observations and events which will affect their task.

b. Operational level

Tasking authorities have to keep their OPCON Authority informed about the progress of work and the status of the enemy mine threat. The frequency of these reports will be ordered in the appropriate MCM Operations Direction (MCMOPDIR).

0604. TYPES OF REPORTS

a. MW Signals

One category of MCM reports are MW-Signals which are found in annex E.
They will normally be applied within MCM Task Groups and by clearance divers. These signals are primarily made for voice transmission although the signals can also be used in other methods of communication. The advantages of these signals is that only relevant letters and/or figures have to be transmitted and describing text will be omitted.

b. Structured messages

Structured messages are used to be transmitted by other means than voice. Although MW-signals can also be transmitted by other means than voice, the advantage of structured messages is found in the fact that the format of such message allows free text to be inserted in the formatted paragraphs. This provides more freedom to provide information to different levels of command.

The formats being used at present concerning MCM operations are found in annex F.

0605. SUMMARY OF MCM REPORTS

This paragraph shows a list of the available MCM reports. The types of reports that are required will be ordered in OPORD, OPDIR and/or TASK ORDER.

REPORT TITLE	OCCASION	TO BE FOUND
OPORD	General description of the operation.	ANNEX A
OPDIR MW 124	To provide directives to tasking authorities. 1. Instructions 2. Message format	1.ANNEX B 2.ANNEX E
TASK ORDER MW 125	To order a tasking to a specific unit. 1. instructions 2. message format	1.ANNEX B 2.ANNEX E
BUOY REPORT MW 126	When laying or checking buoys.	ANNEX E
MCM TASK STOP TIME MW 127	When start of stop time differs from task order.	ANNEX E
MINDETREP MW 128	When a mine has been detected or has been disposed of (only when ordered).	ANNEX E
MCM OPDEF MW 129	Whenever a unit is unable to carry out the task ordered.	ANNEX E
MCM SITREP MW 130	On completion of each stage and task and when ordered.	ANNEX E
RELIEFREP MW 131	Sent by unit being relieved to unit(s) relieving him in the same area.	ANNEX E
LEADTHROUGH ORDER	Passing info to MCM tasking authority about ETA and composition of convoy/naval forces which have to pass a certain channel.	ANNEX G
LEADTHROUGH INFO	To pass info to OTC transitting units about MCM data including valid warnings.	ANNEX G
LEADTHROUGH TRANSIT IN-STRUCTIONS	From OTC MCM-forces to pass necessary info for execution of a leadthrough operation to a naval force, convoy or independent unit.	ANNEX G
PRETECHREP	When finding unknown enemy equipment.	ANNEX F
COMTECHREP	Amplifying report after having sent PRETECHREP.	ANNEX F

Table 6-1. MCM Reports

CHAPTER 7

MINE DISPOSAL EXERCISES

0701. GENERAL

Mine disposal exercises are regularly carried out as part of MCM exercises. They are to provide the Explosive Ordnance Disposal (EOD) teams with the opportunity to train appropriate mine disposal procedures.

0702. CONDUCT OF MINE DISPOSAL EXERCISES

a. Mine disposal can be trained using the following material and techniques:

Objects	Disposal technique
Drifting mine	Small arms firing MCM diver
Moored mine	ROV MCM diver
Ground mine (exercise)	Explosive techniques (e.g. cutting technique)
Ground mine (explosive filled)	High order disposal Low order disposal Neutralisation techniques

Table 7-1. Disposal objects against disposal technique

b. The exercise mines and objects may be used for

(1) procedural training, (i.e. explosives are not fired, but all the relevant procedures are performed),

(2) or they may be used for actual disposal (i.e. the use of explosives is allowed).

c. Other types of mines, either historical or explosive filled objects may be used to produce an explosion equivalent to that of a combat mine.

d. The disposal of combat mines may also serve as a demonstration to all exercise participants, enabling them to see the actual plumes and feel the shock waves.

0703. SAFETY ASPECTS

The following safety precautions apply when exercising or demonstrating mine disposal:

- Prior to the demonstration the amount of TNT equivalent to be exploded must by announced.
- Divers in the water must maintain proper safety distance in accordance with national regulations.
- Observing ships must maintain proper safety distance to avoid shock damage.

CHAPTER 8

PLANNING AND EVALUATION

SECTION 1

GENERAL

0801. INTRODUCTION

a. This chapter provides instructions for:

(1) Determining the number of runs per track (J) and the percentage clearance (P) for operations in which the objective is clearance. The instructions correlate the actuation/cutting/search parameters and sweeper safety parameters with the standard deviation of navigational error (σ) to assist the MCM Commander in obtaining maximum effectiveness from his forces.

(2) Planning and evaluating an exploratory operation.

b. The standard deviation of navigational error (σ) and the characteristic actuation/sweep path/detection width (A) and the channel width (C) used in this chapter for determining the track spacing (D) can be in either units of yards or metres. However σ, A and C must be in the same units and the determined value of D will be in the same corresponding units.

c. For all operations the planning parameters should be re-evaluated in the light of observations during the operations. Observed changes must be reported.

0802. TERMS IN MCM PLANNING

a. General

The following factors are to be taken into account, where applicable, in the execution of MCM operations:

(1) Track spacing (D)
(2) Number of runs per track (J)
(3) MCM patterns

b. Track Spacing (D)

(1) Track spacing (D) is the perpendicular distance or lateral separation between two adjacent tracks. Track spacing for MCM operations is initially based on the countermeasures pattern used, and on an assumed navigational and localization error and values of actuation/cutting/detection parameters (see para 0804b). Track spacing may be dragged in accordance with the actual navigational errors and values of A and B experienced during the conduct of the operation.

(2) Normally $D \leq 2\sigma$ which is a condition necessary to be able to lump tracks ($J > 1$). Usually $D = 2\sigma$ is taken, unless calculations show the advantage of $D < 2\sigma$ permitting an economy in total number of runs.

(3) In the case of a large A and small σ the calculated J may be smaller than one ($J < 1$). In this case J is set equal to 1 and D recalculated. Then D is greater than 2σ. This is particularly the case with mine hunting systems.

c. Track Runs

The number of times the countermeasures gear must follow each track is defined as the number of runs per track (J).

d. MCM Pattern

A mine countermeasures pattern is a way of distributing sweeping, hunting or diving runs within an area or a channel. The term distribution, as used here, includes the general procedure for laying out tracks and the sequence and distribution of runs on the various tracks. The pattern in use is the uniform pattern.
In this pattern, runs are made along a series of tracks equally spaced across a channel or throughout an area. The same number of runs is made on each track. The order in which tracks are swept or hunted will not affect the ultimate degree of clearance. However, it will affect the risk to the MCMV in some operations and it may affect the degree and uniformity of clearance at times during the operation.

0803. STANDARD DEVIATION OF NAVIGATIONAL ERROR (SDNE)

This is the term applied to the navigational error computed for use in statistical MCM operations. Numerically, it is the root mean square of the navigational error.

0804. MINE COUNTERMEASURES EQUIPMENT PARAMETERS

a. Introduction

(1) In mechanical sweeping for moored mines, in sweeping and hunting for moored influence and ground influence mines, the cutting, actuating, or detection of a mine of a given type on a given run may not be certain. Several factors could contribute to this uncertainty, for example the arming of mechanical sweeps or the effectiveness of the cutters, the uncertainty of actuation or detection because of mine position or orientation, local physical environmental characteristics of the sea affecting the sweep or hunting gears performance and navigational inaccuracies of the MCMV. All these factors can be accounted for in evaluating the results of sweeping and hunting through the application of statistics to mine countermeasures.

(2) Certain parameters are used in the planning and evaluation of MCM operations. These parameters provide the means for measuring both the effectiveness of a particular technique against a particular mine in a certain environment, and the danger to the MCMV while using the technique. The relationship of these parameters is shown in Figures 8-1 to 8-4 and is described in the following paragraphs.

(3) One can distinguish:

(a) Actuating/cutting/detection parameters.

(b) Safety parameters.

(4) Evaluation and planning in this chapter is based upon the principle that parameters are calculated by means of known or the assumed relationship between sweep/hunting technique and the mine and its environment, or that parameters are deduced from the signature produced by the target to be protected.

b. Actuation/Cutting/Detection Parameters

(1) DEFINITIONS

Parameters are established for the actuation, cutting and detection of mines for influence sweeping, mechanical sweeping and mine hunting respectively. The parameters are designed to describe the effectiveness of a counter-measures gear or system against the mine. They are based on the probability P(y) of actuating, cutting or detecting the mine as a function of lateral distance y from the centre of the MCM gear.

(2) THESE PARAMETERS ARE:

(a) Aggregate Actuation/Cutting/Detection Width (W). This is defined as the area under the curve P(y) plotted as a function of the lateral distance y. See Figure 8-1.

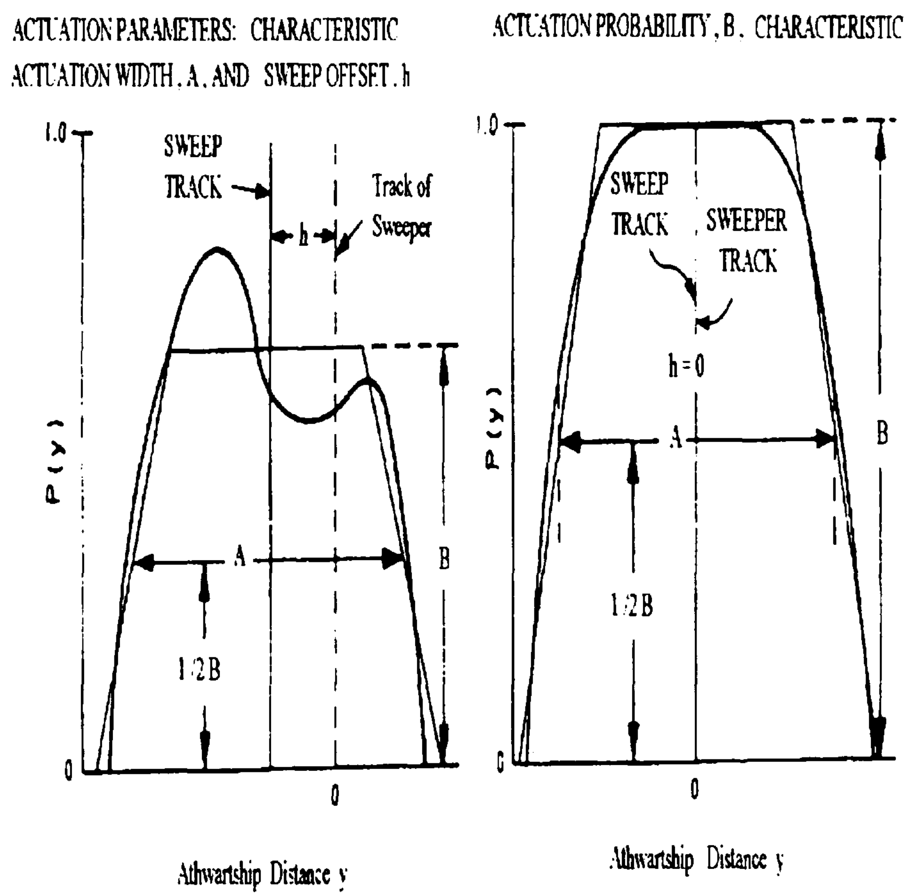


Fig 8-1. Actuation Parameters

(b) Characteristic Actuation/Cutting/Detection Probability (B).
This is the height of a trapezoid or rectangle that most closely fits the curve of P(y). The area of the trapezoid or rectangle determined must be equal to the area under the curve.

(c) Characteristic Actuation/Cutting/Detection Width (A).
This is the width of the trapezoid at one-half B or the width of the rectangle. In some particular cases e.g. sweeping horizontal field single component magnetic mines, two groups of actuation parameters, the lower characteristic (A) and average characteristic (A) actuation widths are used for different objectives. Correspondingly the lower aggregate (W) and average aggregate (W) actuation widths are used.

(3) DEVELOPMENT OF PARAMETERS

(a) The development and relationship of the parameters defined above are shown in Figures 8-2 to 8-4 for influence sweeping. Since these figures indicate the results for one run, the situation is analogous to mechanical sweeping and minehunting. Figure 8-2 is a display of a minefield in a geographic setting. The figure also indicates the results of one sweep run. Figure 8-4 shows the same results as a cumulative plot of all mine actuations relative to the sweeper. As the sweeper moves along the track, the range and bearing to each mine actuation is recorded. At the end of the run, the ranges and bearings are plotted from a single point as shown in Figure 8-5. In this type of plot some mine actuations may coincide. Figures 8-2 and 8-3 show the effect of a given sweeping technique employed against poised mines of a given type in a given environment.

(b) The result from Figure 8-3 can now be plotted graphically as shown in Figure 8-4A. The probability (P(y)) of actuation is plotted as a function of the athwartship distance (y). The curve that is formed is then superimposed on a trapezoid or rectangle as shown in Figure 8-4B. The height of the trapezoid or rectangle is the Characteristic Actuation/Cutting/Detection Probability (B). A line is now drawn parallel to the horizontal axis at one-half B. The distance between this point on B and the intersection of the parallel line with the side of the trapezoid or rectangle is the Characteristic Actuation/Cutting/Detection Width (A). As shown in Figure 8-4B, the Characteristic Actuation/Cutting/Detection Width is only one-half, since only one-half of the trapezoid or rectangle has been drawn. The area of the full trapezoid or rectangle can be determined from the product of A and B. This product is the Aggregate Actuation/Cutting/Detection Width (W); W equals A times B.

(c) For some techniques and mines the probability curve may reach as high as unity, while for other techniques and mines the probability curve may not reach unity, or it may be irregular in shape. These variations are illustrated in Figure 8-1. Mathematically, the area under the probability curve has the dimensions of a width (since it is essentially the product of a probability and a width) and it is called the Aggregate Actuation/Cutting/Detection Width (W). W does not correspond to any actual physical width or distance from the sweep. A is a definite width and has a definite location with respect to the position of the MCM gear.

(d) In the same way, the probability (P(y)) that use of a given hunting technique in given circumstances will result in detection and classification of mines will vary with athwartship distance (y). Just as for sweeping, this probability can be plotted as a function of y, as in Figures 8-2 to 8-4. The area under the detection probability curve is the Aggregate Actuation/Cutting/Detection Width (W). The Aggregate Actuation/Cutting/Detection Width is used for analyzing the effects of detection and classification in using the hunting technique, but does not include the effects of classification and disposal.

c. Characteristic Classification Probability (B_c)

B_c is the classification probability associated with the sonar system being used.

d. Characteristic Disposal Probability (B_n)

B_n is the disposal probability associated with the disposal system being used.

e. Sweep/Hunting Gear Offset (h)

The perpendicular distance between the centre of the characteristic width, 'A' (the sweep/hunting gear track), and the track of the MCMV is the sweep/hunting gear offset. The intended track of the MCMV must be displaced from the intended track of the sweep or hunting gear by the amount of the offset. Since the MCMV must maintain the sweep/hunting gear on the sweep/hunting gear track, it is also necessary for the MCMV to allow additional corrections for the effects of crosswinds and current, which are not included in the values of h.

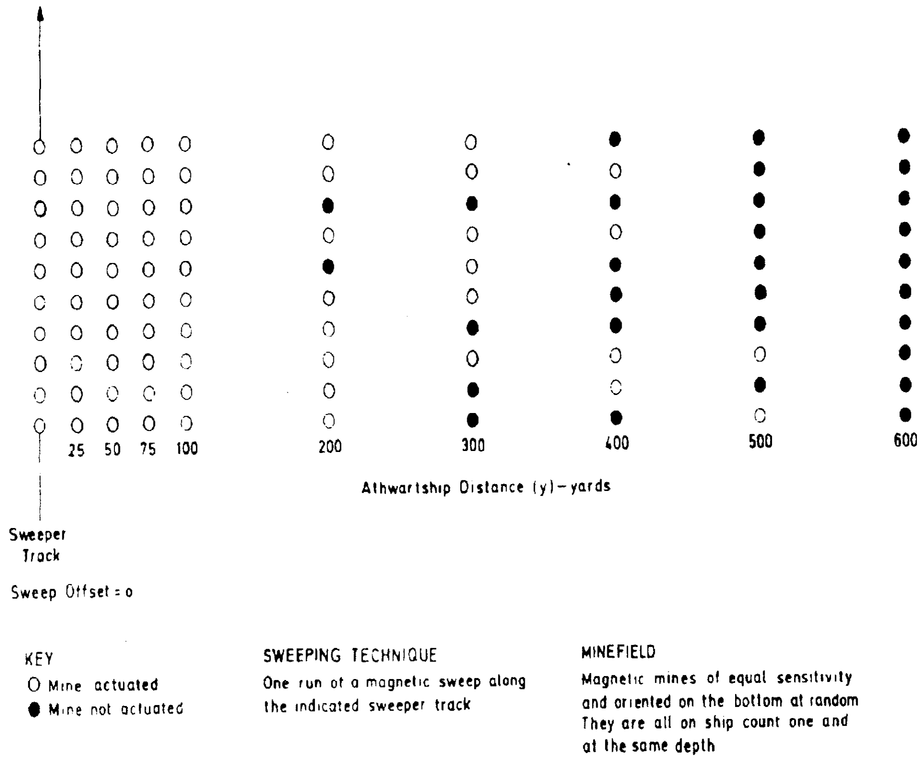


Fig. 8-2. Display of Actuation in Given Minefield

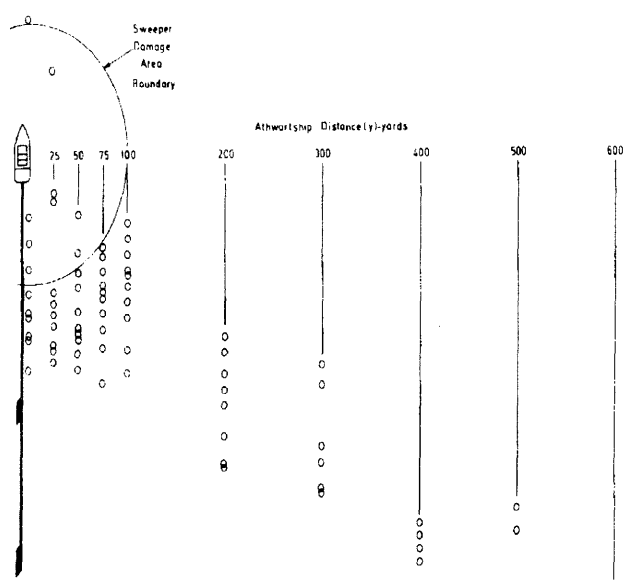


Fig. 8-3. Display of Actuation Position Relative to the Sweeper

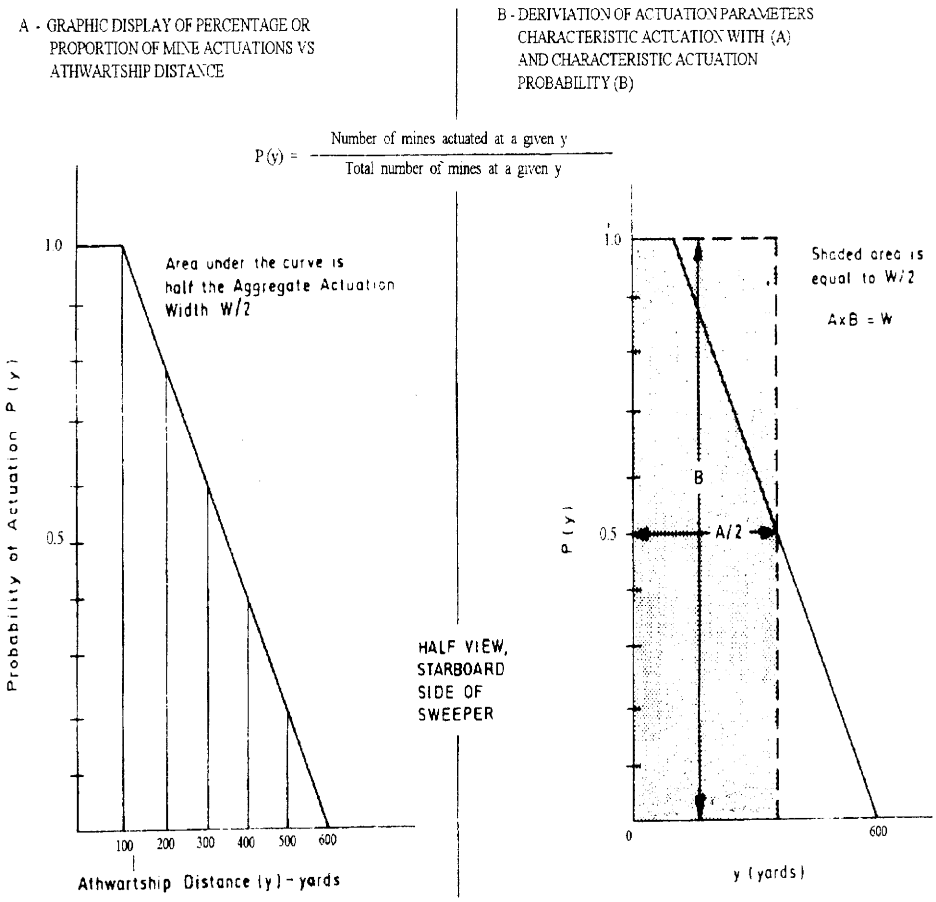


Fig. 8-4. Actuation Parameters

0805 - 0809. SPARE

SECTION 2

MCMV RISK AND SAFETY

0810. PARAMETERS OF CALCULATING MCMV RISK AND MCMV SAFETY

a. MCMV Risk

(1) MCMV risk is defined as the probability that a poised mine of given characteristics, exploded by the sweeping or hunting technique in use, will explode within the damage area of the MCMV. For example, if a given sweeping or hunting technique is expected to result in nine mines being fired outside the damage area for every mine exploded inside the damage area, R equals 0.10.

$$\text{Thus } R = \frac{\text{expected value of number of mines exploded within the damage area}}{\text{expected value of total number of mines exploded}}$$

(2) When the threat to the sweeper comes from mines fired by the sweep in the vicinity of the sweeper and for mechanically sweeping contact mines, MCMV risk may be estimated from the following formula:

$$R = \frac{(F)\ x(Bd)}{(A)\ x\ (B)}$$

When the influence field of the sweeper or hunter is large enough to actuate mines, it may be assumed that these actuations will be within the damage area of the MCMV. When the MCMV can actuate mines and when (F) x (Bd) is near the value of or larger than (A) x (B), R can be more accurately represented by adding (F) x (Bd) to (A) x (B) in the denominator of R. This adjustment to R will only be significant when mines are likely to be fired by the MCMV and only applies to situations which should be avoided.

(3) The value of R is valid for the first run on the first track.

b. MCMV Safety Measures

(1) Safety of the MCMV is one of the most important factors to be considered when choosing appropriate techniques and patterns. Protection of the MCMV from mine explosion damage is always important, even when the urgency of the operation demands that the rate of sweeping or searching be considered foremost.

(2) SAFE PROCEDURES
Safe procedures are intended to prevent any mine from firing within the damage area or to minimize the risk incurred by the MCMV carrying out MCM operations. One method is to apply the correct sequence of stages. Other methods are stated below.

(3) Fig 8-6 gives an example of the application of a minesweeping technique and the associated MCMV risk.

(4) MCMV SAFETY PARAMETERS
When a MCMV passes close to a poised mine, there is a probability that the mine will be exploded forward of the damage area, within the damage area or aft of the damage area. The cumulative effects of these three possibilities are caused either by the MCMV, the sweep or a combination of both. The probability that a mine will explode within the damage area at an athwartship distance y, is designated Pd(y). Two forms of the curve of Pd(y) plotted as a function of y are shown in Fig 8-5. Three parameters for MCMV safety can be determined from the probability curve. These are:

(a) Dangerous front (F), which is the maximum width of the curve of Pd(y) plotted as a function of y.

(b) Aggregate Damage Width (Wd) which is the area under the curve of Pd(y).

(c) Damage Probability, (Bd), which is the weighted average value of Pd(y) within F, thus

$$Bd = \frac{Wd}{F}$$

These parameters are shown with some additional features in Fig 8-7 and are discussed further.

(5) Figure 8-8 illustrates the development of these safety parameters. Part A of the figure is a plot of the results obtained from the first 100 m athwartship distance of one sweeping run. The probability of explosion (Pd) within 100 m of the MCMV is plotted as a function of the athwartship distance y.

(6) From the curve, half of which is plotted in Part A of Figure 8-8, the MCMV safety parameters are determined as shown in Figure 8-8, Part B. F is determined from the intersection of the curve with the horizontal axis y. Wd is the arc under the curve Pd(y) and is determined by adding the individual values of Pd(y) at various distances of y and then dividing by the total number of y's taken.

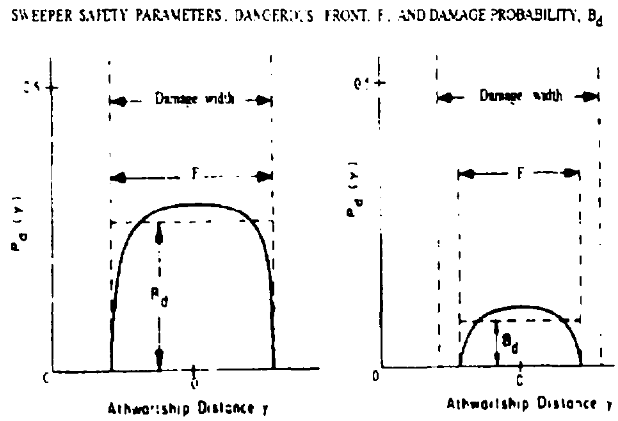


Fig 8-5. MCMV Safety Parameters

c. MCMV Damage Area

(1) The damage area of a MCMV approximates to a cylinder (the vertical axis of which passes through the centre of gravity of the ship) of 100 m radius for a charge of 1000 kg of TNT. This theoretical damage area is thus independent of the depth of water. Its radius varies as the square root of the weight of explosive charge in units of TNT.

(2) There are two influence firing areas; the firing area of the sweep, and that of the vessel. These two areas are not always separate, since the influences due to sweep and vessel may combine. Thus:

(a) A 200 nT magnetic mine may detonate dangerously within the shock zone because to the 150 nT due to the sweep are added the 50 nT due to the vessel.

(b) A 5 Pascal(Pa) acoustic mine may be influenced because to the 4 Pa due to the sweep are quadratically added the 3 Pa due to the vessel.

However, the two above areas are assumed to be separate, so we calculate the dangerous front in relation to these two danger areas.

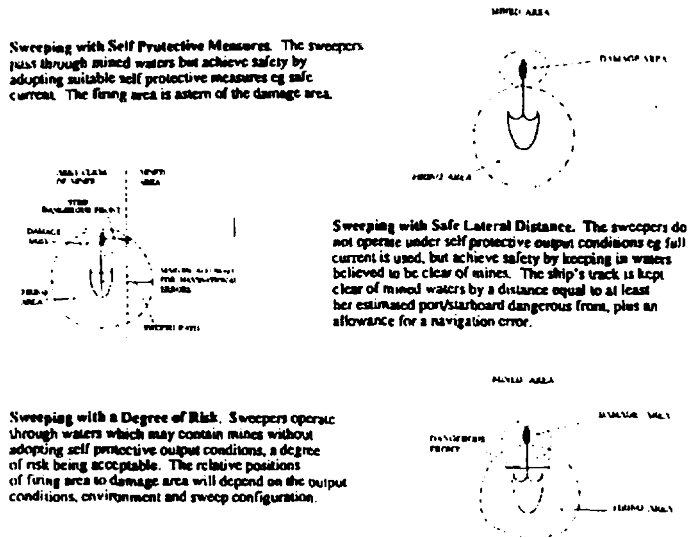


Fig 8-6. Application of Minesweeping Techniques

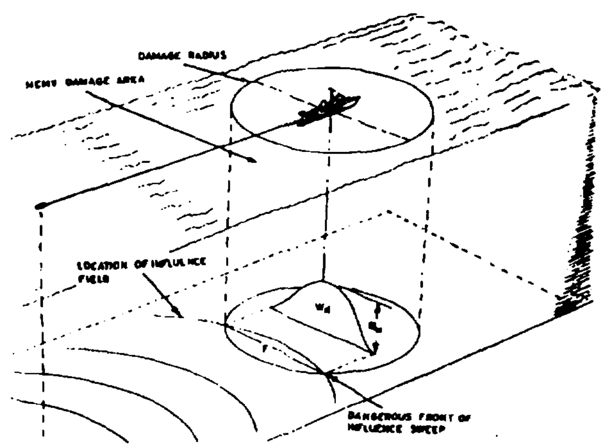


Fig 8-7. Damage Radius, Damage Area, Dangerous Front, Damage Probability and Aggregate Damage width

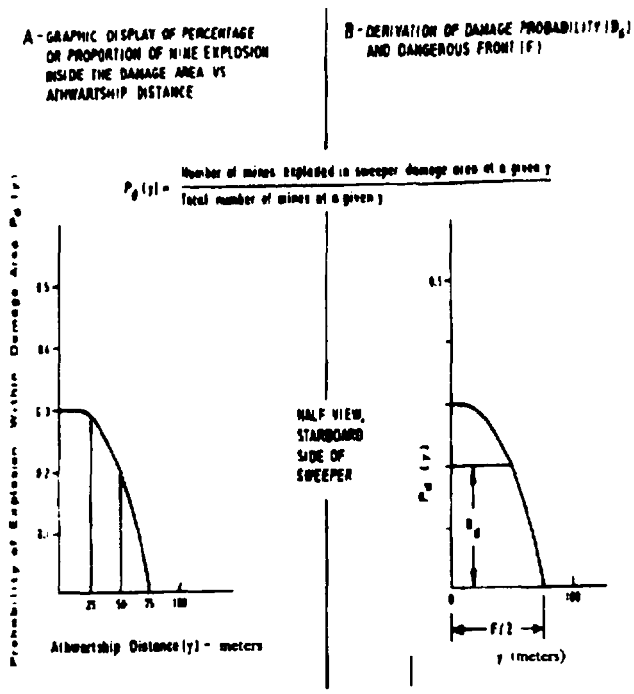


Fig 8-8. MCMV Safety Parameters

d. Risk and Influence Sweep Efficiency

(1) Without prior intelligence, the potential efficiency of an influence sweep operation cannot be satisfactory estimated, and if it must proceed it will be planned on the basis of 'best guess'. But as intelligence is gathered (as a result of precursor operations, mine recoveries, casualties etc) planning aim proceed on a more certain basis. However, there are some factors common to influence sweeping operations, and so far as these affect the potential risk to the MCMV, they can be taken into account from the beginning.

(2) For example, the more efficient an influence sweeping operation, the more mines are actuated, and the greater the risk to the sweeper. Thus, in terms of operational efficiency, any estimate of Actuation Probability (B) is also, in effect, an estimate of Damage Probability (Bd) to the sweeper. Similarly, any estimate of Swept Path (A) may also, in the circumstances described shortly, reflect upon the estimate of Dangerous Front.

(3) When influence sweeping a regular pattern minefield, the probability is that the highest number of mine actuations will occur along or near the track of the sweep (and sweeper if they are in line). This probability is shown in simple graphic form in Fig 8-9 where actuations are

plotted against distance. The centreline of the curve represents the track of the sweep. The area under the curve shows the probable efficiency of sweep operation. If a rectangle is drawn having the same area as that under the curve, then:

Dimension A = Swept Path, and
Dimension B = Actuation/Cutting/Detection Probability.

This graph which here represents efficiency of the sweep operation, can also be considered for its implications to MCMV risk.

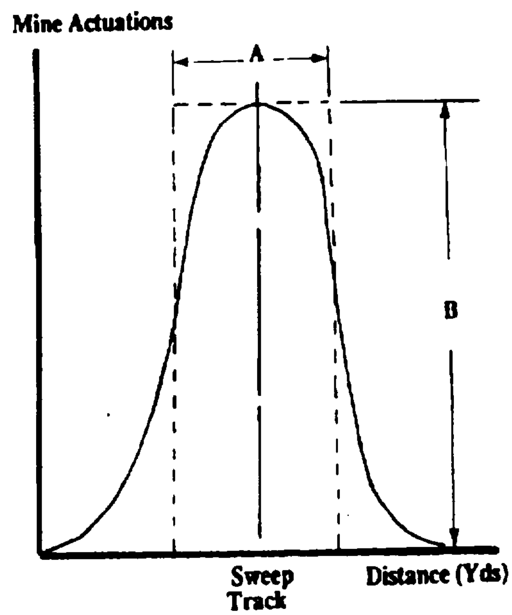


Fig 8-9. Probability of Mine Actuation relative to the Sweep Track

e. Dangerous Front

Considering the influence of the sweep alone, it is omni-directional and has the potential to actuate mines out to its periphery. If the sweep periphery overlaps the danger area of the sweeper then there is a potential that not only medium sensitive mines may be actuated, but that coarse mines may be fired under the combined influence of sweep and sweeper. A line cutting the intersects of the sweep influence and the sweeper dangerous area circle is called the Dangerous Front (F), and this has relationship with both the amount of overlap and the Swept Path width.

f. Damage Probability

Once again, the Damage Probability (Bd) is related to the Detection Probability (B), since the same factors apply, that is, the most mine actuations will probably occur along the line of the sweep (and sweeper), and the more actuations there are the more likelihood of damage to the MCMV.

g. Aggregate Damage Width

The Aggregate Damage Width (Wd) is a statistical estimate of the potential vulnerability of an MCMV to mine damage in a given circumstance. It is the product of Dangerous Front and Damage Probability.

Wd =F x Bd

h. Self-Protection Depth for MCMVs (Fig 8-10)

When minesweeping, the 'self-protection depth' is the depth where there is no overlap between the firing area and the sweeper damage area. In some cases, there is no overlap from the surface down to self-protection depth. In other cases there may be no overlap from self-protection depth down to the bottom. Again, there may be no overlap between two depths, of which one is the self-protection depth of the field of the MCMV (safe depth) and the other the self-protection depth of the field of the sweep in use.

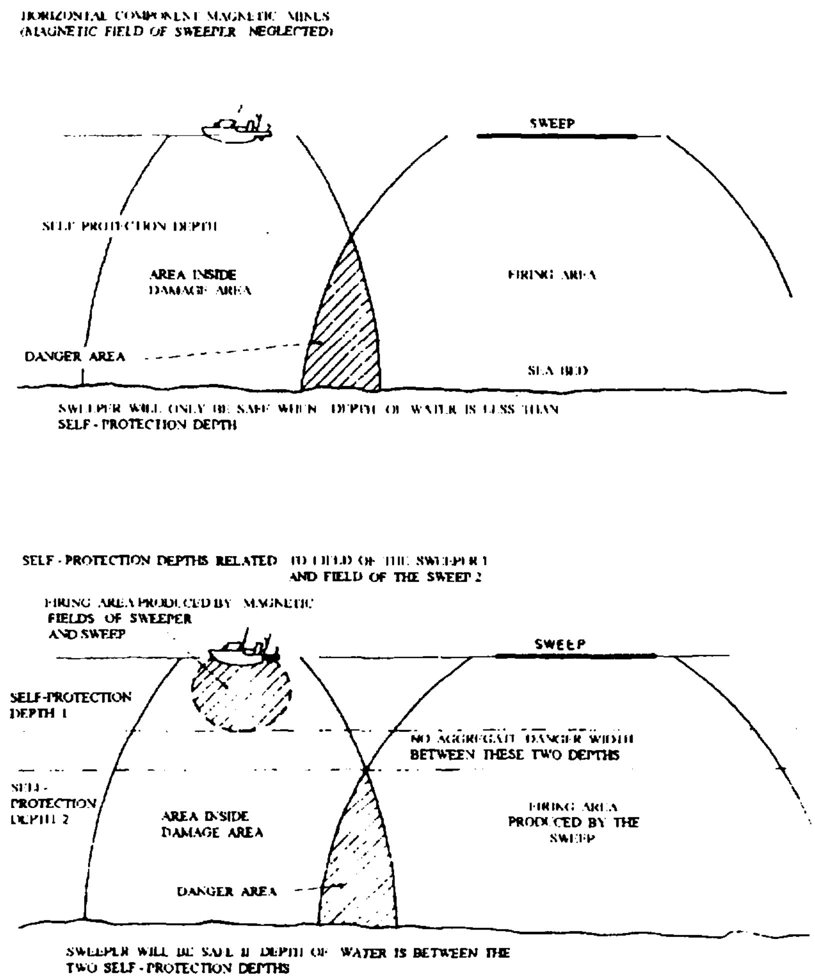


Fig 8-10 Self-Protective Depth for MCMVs

0811 - 0819. SPARE

SECTION 3

CLEARANCE OPERATIONS

0820. GENERAL

a. Definitions and principles of a clearance operation

(1) The aim of a clearance operation is to achieve a high probability of clearing any mine in a channel/area.
This probability of clearing any mine is also defined as the mathematical expectation (P) of the fraction of the total number of mines of that type (including unsweepable and/or undetectable mines) that will be cleared. In the present context this mathematical expectation is also defined as percentage clearance. The actual percentage of mines cleared in such an operation may differ substantially from the theoretical percentage clearance aimed at.

(2) To plan or to evaluate a clearance operation, use is made of probability theory.

b. Percentage clearance to be achieved

(1) In order to obtain a high probability to clear any mine, the percentage clearance aimed at should be at least 96 ($P \geq 96$).
To increase the percentage clearance respectively from 94 to 96 or from 96 to 98 an average increase of MCM effort of respectively 13 to 20 % is needed.

(2) If a percentage clearance of 96 cannot be achieved with one technique, other technique(s) should be used in the same channel/area.

(3) It is to be noted that the maximum percentage clearance is:
$(1-\mu_s)$ for sweeping and $(1-\mu)B_cB_n$ for hunting. In multiple coverage the maximum percentage clearance will be given by the technique yielding the maximum value from the above formula's.

c. Definition of calculated percentage clearance

Due to the fact that unsweepable and/or undetectable mines can be present, a calculated percentage clearance (P_{cal}) is introduced. The calculated percentage clearance is the mathematical expection of the fraction of sweepable or detectable mines that can be cleared. The relation between the percentage clearance (P) and the calculated percentage clearance (P_{cal}) in sweeping is $P = P_{cal}\ (1-\mu_s)$. The relation between the percentage detection (P_d) and the P_{cal} in hunting for detection is $P_d = P_{cal}\ (1-\mu)$.

d. Extension of P_{cal}

(1) Clearing a mine during minehunting operations is achieved after the sequential processes of detection, classification and/or identification and disposal.

(2) The detection process normally dominates the other processes. Classification is not necessary if detailed survey information is available.
To quantify these processes the following definitions are needed :

(a) characteristic detection probability (B).

(b) characteristic detection width (A).

(c) classification probability (B_c) : the probability of classifying an object correctly after detection, if the object is in fact a mine.

(d) disposal probability (B_n) : the probability of disposing of an object that has been classified correctly if the object is in fact a mine.
If repeated identification/disposal runs are made in order to ensure a positive/correct identification/disposal, B_n can be taken equal to unity.

(3) The percentage detection is defined as the mathematical expectation of the total number of detectable mines that will be detected. Thus the percentage clearance P being expressed in relation to clearing mines, after the detection phase correct classification and disposal must be performed thus :
$P = P_d \, B_c \, B_n$ (or $P_d = P \, / \, B_c \, B_n$)
Therefore in <u>hunting</u> the formula is extended in order to include B_c and B_n as follows : $P = P_{cal} \, (1-\mu) \, B_c \, B_n$.

(4) The formulas used above are only correct if the performance of the system is such that if an object has been classified once, the classification process will not be repeated after a "new" detection of the same object.

(5) Finally the formulas of P_{cal} are in sweeping :

$$P_{cal} = \frac{P}{(1-\mu_s)}$$

in hunting :

$$P_{cal} = \frac{P}{(1-\mu) \, B_c \, B_n}$$

(For the tables, if P_{cal} = 100 % we will use 99 %).

e. Probability to sweep or hunt all mines

If the percentage clearance is the probability to effectively counter each mine, the chance or probability to sweep/hunt ALL mines present if there were t mines is : p^t.

The probability of hunting all detectable mines or of sweeping all mines of a particular type, sensitivity and ship count setting which have been cleared to a given percentage clearance can be readily determined from Fig 8-11. Similarly, the percentage clearance which is required for a particular probability that all detectable mines are hunted or that all mines of a particular type, sensitivity and ship count settings are swept can also be determined from Fig 8-11. Fig 8-11 shows the way in which the probability of countermeasuring a particular mine type varies with the percentage clearance for various estimates of the total number of the particular mine type expected. For example if there are 10 mines of a particular type in the channel, then to attain a probability of 0.8 of countering all 10 mines, the percentage clearance against them must be 97.8 per cent. In the case of hunting to obtain a probability of 0.8 of finding and disposing of all ten detectable mines in a channel, the percentage of clearance must also be 97.8 per cent.

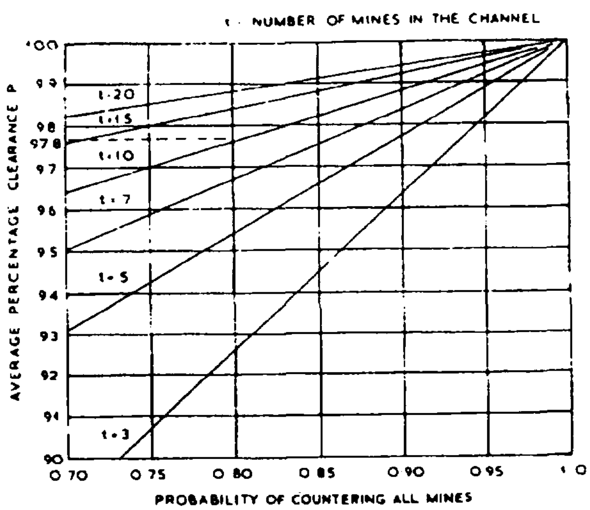


Fig 8-11. Relationship between the Probability of Countering all Mines and the Percentage Clearance

0821. VALIDITY OF CALCULATIONS

a. The following MCM conditions are met :

(1) Minefield is constant (for sweepers : no delayed rising mechanism, no arming delays, no replenishment.For hunters: no replenishment).

(2) No ships are transiting the channel/area during the operation.

(3) The sweeping technique is capable of actuating the mine(s).

b. The following mathematical assumptions are considered :

(1) Mines are distributed randomly (a mine has no preferential position).

(2) Only one actuation/detection possibility per mine, per run.

c. The following data is known or correctly estimated :

(1) MCM and MCM safety parameters.

(2) The SDNE (σ) of the navigation system used.

(3) The distribution of K.

(4) μ and μ_s.

0822. MCM METHODS

a. Single coverage

Single coverage is the execution of a number of runs (J) on a number of tracks (N) with a specific MCM technique (i.e. same parameters).

b. Multiple coverage

Multiple coverage is the execution of a number of runs (J) on a number of tracks (N) with different MCM techniques (i.e. different MCM parameters).

0823. METHOD USED FOR PLANNING AND EVALUATION

The method used is based on the "clearance" of a channel/area and uses the standard deviation of the navigational error (σ) as a statistical efficiency factor along with the basic MCM parameters A and B. This method is applicable to all values of K_{cal} and for all values of A/σ.

0824. NUMBER OF TRACKS AND NUMBER OF RUNS PER TRACK REQUIRED

a. Introduction

(1) To achieve a certain percentage clearance it will be necessary to divide the Channel into tracks and to determine how many runs per track have to be made.

(2) If a run on a track has not been completed the track is not considered valid and therefore not accounted for.

(3) The following tables give the required number of tracks and number of runs per track. These tables are based on the calculated percentage clearance (P_{cal}) (see para 0820). Each table refers to a specific MCM technique and does not reflect the overall Percentage clearance (P). If only one MCM technique is used it may not cover all mine types: this is reflected in the parameter μ/μ_s and in the P_{cal}.

(4) To plan/evaluate the percentage clearance of a Channel (P) for a given minetype by a multiple coverage [e.g. mechanical/hunting and influence sweeping for a given classification probability (B_c) and disposal probability (B_n)] and for a given percentage of non sweepable or not huntable mines (μ/μ_s), use the following approximative formulas:

$P \text{ hunting} = P_{cal} \text{ hunting}(1 - \mu) B_c \times B_n$
$P \text{ sweeping} = P_{cal} \text{ sweeping}(1 - \mu_s)$
$P = 1 - [(1 - P \text{ hunting})(1 - P \text{ sweeping})]$.

(5) To achieve a certain percentage clearance, the following factors have to be taken into consideration. These affect the Characteristic Actuation/cutting/detection Width and Probability (A and B) and the number of mines which cannot be dealt with by the technique used (μ/μ_s) (see also paras 0814 and 0831):
- the intelligence on the mine threat
- the environment
- the MCM technique and equipment used
- the experience of the ships staff and crew

Therefore the determination of these important parameters depend not only on the equipment characteristics but also on the Commanders' experience, military judgment and assets available for evaluation (e.g. sonar performance monitor; sonar prediction model, etc.)

(6) The tables are based on statistics and are grouped around the mostly used values in current MCM techniques. Covering all values is not possible. Although the results are not linear, it can be accepted, with some approximation, for intermediate values to interpolate between the tables.

b. Use of the tables

(1) parameters used:

Channel width: 400 and 800 m.
SDNE: Standard deviation of navigational error: 10; 25; 50 and 75 m.
Required calculated percentage clearance: 50; 60; 70; 80; 90; 95 and 99%
Characteristic Detection/Cutting Width: 150; 200; 250; 300; 400 and 500m. (shipcount 1)
Characteristic Actuation Width: 100; 150; 200; 250 and 300m. (shipcount 5)
Characteristic Detection/Cutting/Actuation Probability: 0.5; 0.55; 0.6; 0.65; 0.7; 0.75; 0.8; 0.85; 0.9 and 0.95

(2) Examples:

(a) Question: Find required number of tracks.

Given:
Channel width 400m
Technique: Mechanical sweeping
Characteristic Cutting Width: 200 m.
Characteristic Cutting Probability: 0.95
SDNE: 50 m.
Required P_{cal}: 95%
Runs per track:1

Solution:
Take table for Mechanical sweeping: Channel Width 400 m. and SDNE 50 m.

- The intersection of P_{cal} equal 95% for 200m Characteristic Cutting Width and 0.95 Characteristic Cutting Probability gives 4 tracks.

(b) Question: Find required number of tracks

Given:
Channel width 800 m.
Technique: Hunting
Characteristic Detection Width: 400 m
Characteristic Detection Probability: 0.85
SDNE: 25 m.
Required P_{cal}: 99%
Runs per track: 1

Solution:
Take table for Hunting for a Channel Width of 800 m with SDNE 25 m.

- The intersection of P_{cal} equal 99% for 400 m Characteristic Detection Width and 0.85 Characteristic Detection Probability gives 6 tracks.

(c) Question:Find required number of tracks and runs per track.

Given :
Channel width 800 m.
Technique: Influence sweeping
Characteristic Actuation Width: 200 m.
Characteristic Actuation Probability: 0.8
SDNE: 75 m.
Required P_{cal}:90%

Solution:
Take table for Influence sweeping for a Channel Width of 800 m with SDNE 75 m.

- The intersection of P_{cal} equal 90% for 200m Characteristic Actuation Width and 0.8 Characteristic Actuation Probability gives 4 tracks and 10 runs per track.

(d) Question: Find achieved P_{cal} for a single coverage.

Given:
Technique: hunting
Channel width 800 m.
SDNE 25 m.
Characteristic Detection Width 500 m.
Characteristic Detection Probability 0.8
number of tracks: 5

Solution:
Take table for hunting for a Channel Width of 800 m with SDNE 25 m.

- Enter the column of 0.8 Characteristic Detection Probability and the rows of 500 m Characteristic Detection Width until finding 5 tracks. At the left margin of this row find the corresponding percentage P_{cal} of 99%.

(e) Question: Find P for a multiple coverage.

Given:
The examples of hunting and sweeping of the 800 m channel width above with of subpara (d) and (c) a P_{cal} result for the hunting technique of 99% and for sweeping P_{cal} 90%
minetype: bottom influence magnetic /acoustic mine
It is the commanders' assessment that μ is 0,05 (5% non huntable mines)
μ_s: 0 (it is supposed that a correct appropriate sweep pulse for that minetype is used)
B_c:0,95 (based on the commanders' assessment of the sonar conditions during that operation)

B_n: 1 (it is assessed that each disposal is successfull)

Solution:

-the combined P for the multiple coverage:

(1) P = 1 - [(1 - P hunting)(1- P sweeping)]

(2) P hunting = P_{cal} $(1 - \mu) B_c B_n$
0.99(1-0.05)0.95x1
approximated = 0.9

(3) P sweeping = P_{cal} $(1 - \mu_s)$.
= 0.90 (1 - 0)
= 0.9

substitute (2) and (3) in (1)
P= 1 - (0.1)(0.1)
= 1 - (0.01)
= 99%

Values of Standard Deviation for Planning Purposes

Method	Standard in meters deviation
Optical line of bearing	10
Horizontal sextant angles	15
Theodolite tracking	15
Hydrographic Decca	40 (1)
Radar danning	45-90(2)
Ordinary danning	45-90(2)
Navigational Decca	45-180(1)
Compass fixing under:	
excellent conditions	70(3)
good conditions	70-140(3)
poor conditions	180-270(4)
Toran	25
GPS	12

Notes

1. Subject to variation according to geographical and weather conditions and also time of day.

2. Depent upon method used for fixing dans and types of danbuoys used.

3. Fixing by taking three bearings. The figures can be lowered when radar is used concurrently.

4. Distant landmarks, poor visibility, insufficient cross-checking. Infrequent fixing, and so on

Table 8-1. Values of Standard Deviation for Planning Purposes

Minehunting/Mechanical Mine Sweeping
Number of Tracks Required (1 Run per Track)

Channel Width (m)	400
SDNE (m)	10

P_{cd}:	Characteristic Detection/Cutting Width	Characteristic Detection/Cutting Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	150	3	3	3	3	2	2	2	2	2	2
	200	3	2	2	2	2	2	2	2	2	2
	250	2	2	2	2	2	2	2	1	1	1
	300	2	2	2	2	1	1	1	1	1	1
	400	2	1	1	1	1	1	1	1	1	1
	500	1	1	1	1	1	1	1	1	1	1
60	150	4	4	3	3	3	3	3	2	2	2
	200	3	3	3	2	2	2	2	2	2	2
	250	3	2	2	2	2	2	2	2	2	2
	300	2	2	2	2	2	2	2	1	1	1
	400	2	2	2	1	1	1	1	1	1	1
	500	2	2	1	1	1	1	1	1	1	1
70	150	5	5	4	4	3	3	3	3	3	2
	200	4	4	3	3	3	2	2	2	2	2
	250	3	3	3	2	2	2	2	2	2	2
	300	3	3	2	2	2	2	2	2	2	1
	400	2	2	2	2	2	1	1	1	1	1
	500	2	2	2	2	1	1	1	1	1	1
80	150	7	6	5	5	4	4	3	3	3	3
	200	5	5	4	4	3	3	3	2	2	2
	250	4	4	3	3	3	2	2	2	2	2
	300	4	3	3	3	2	2	2	2	2	2
	400	3	3	2	2	2	2	2	1	1	1
	500	3	2	2	2	2	2	1	1	1	1
90	150	9	8	7	6	6	5	4	4	3	3
	200	7	6	6	5	4	4	3	3	3	2
	250	6	5	5	4	4	3	3	2	2	2
	300	5	4	4	3	3	3	2	2	2	2
	400	4	3	3	3	2	2	2	2	2	1
	500	3	3	3	2	2	2	2	2	1	1
95	150	12	11	9	8	7	6	6	5	4	3
	200	9	8	7	6	6	5	4	4	3	3
	250	7	7	6	5	5	4	4	3	3	2
	300	6	6	5	4	4	3	3	3	2	2
	400	5	4	4	3	3	3	2	2	2	2
	500	4	4	3	3	3	2	2	2	2	1
99	150	18	16	14	12	11	10	8	7	6	5
	200	14	12	11	9	8	7	6	5	5	4
	250	11	10	9	8	7	6	5	4	4	3
	300	9	8	7	6	6	5	4	4	3	3
	400	7	6	6	5	4	4	3	3	3	2
	500	6	5	5	4	4	3	3	2	2	2

Table 8-2.

Minehunting/Mechanical Mine Sweeping
Number of Tracks Required (1 Run per Track)

Channel Width (m)	400
SDNE (m)	25

P..	Characteristic Detection/Cutting Width	Characteristic Detection/Cutting Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	150	3	3	3	3	2	2	2	2	2	2
	200	3	2	2	2	2	2	2	2	2	2
	250	2	2	2	2	2	2	2	1	1	1
	300	2	2	2	2	1	1	1	1	1	1
	400	2	1	1	1	1	1	1	1	1	1
	500	1	1	1	1	1	1	1	1	1	1
60	150	4	4	3	3	3	3	3	2	2	2
	200	3	3	3	2	2	2	2	2	2	2
	250	3	2	2	2	2	2	2	2	2	2
	300	2	2	2	2	2	2	2	1	1	1
	400	2	2	2	1	1	1	1	1	1	1
	500	2	2	1	1	1	1	1	1	1	1
70	150	5	5	4	4	3	3	3	3	3	2
	200	4	4	3	3	3	2	2	2	2	2
	250	3	3	3	2	2	2	2	2	2	2
	300	3	3	2	2	2	2	2	2	2	1
	400	2	2	2	2	2	1	1	1	1	1
	500	2	2	2	2	1	1	1	1	1	1
80	150	7	6	6	5	4	4	4	3	3	3
	200	5	5	4	4	3	3	3	2	2	2
	250	4	4	3	3	3	2	2	2	2	2
	300	4	3	3	3	2	2	2	2	2	2
	400	3	3	2	2	2	2	2	1	1	1
	500	2	2	2	2	2	2	1	1	1	1
90	150	10	9	8	7	6	6	5	4	4	4
	200	7	7	6	5	5	4	4	3	3	3
	250	6	5	5	4	4	3	3	3	2	2
	300	5	4	4	4	3	3	3	2	2	2
	400	4	3	3	3	2	2	2	2	2	1
	500	3	3	3	2	2	2	2	2	1	1
95	150	13	11	10	9	8	7	6	6	5	4
	200	9	8	7	7	6	5	5	4	4	3
	250	8	7	6	5	5	4	4	3	3	2
	300	6	6	5	4	4	4	3	3	2	2
	400	5	4	4	3	3	3	2	2	2	2
	500	4	4	3	3	3	2	2	2	2	1
99	150	19	17	15	13	12	11	10	8	8	7
	200	14	13	11	10	9	8	7	6	5	5
	250	11	10	9	8	7	6	5	5	4	4
	300	10	8	7	7	6	5	5	4	3	3
	400	7	6	6	5	4	4	3	3	3	2
	500	6	5	5	4	4	3	3	2	2	2

Table 8-3.

Minehunting/Mechanical Mine Sweeping
Number of Tracks Required (1 Run per Track)

Channel Width (m)	400
SDNE (m)	50

$P_{c..}$	Characteristic Detection/Cutting Width	Characteristic Detection/Cutting Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	150	4	3	3	3	2	2	2	2	2	2
	200	3	2	2	2	2	2	2	2	2	2
	250	2	2	2	2	2	2	2	1	1	1
	300	2	2	2	2	1	1	1	1	1	1
	400	2	1	1	1	1	1	1	1	1	1
	500	1	1	1	1	1	1	1	1	1	1
60	150	5	4	4	3	3	3	3	2	2	2
	200	3	3	3	3	2	2	2	2	2	2
	250	3	3	2	2	2	2	2	2	2	2
	300	2	2	2	2	2	2	2	1	1	1
	400	2	2	2	1	1	1	1	1	1	1
	500	2	2	1	1	1	1	1	1	1	1
70	150	6	5	5	4	4	4	3	3	3	3
	200	4	4	4	3	3	3	2	2	2	2
	250	3	3	3	3	2	2	2	2	2	2
	300	3	3	2	2	2	2	2	2	2	1
	400	2	2	2	2	2	1	1	1	1	1
	500	2	2	2	2	1	1	1	1	1	1
80	150	8	7	6	6	5	5	4	4	4	3
	200	6	5	5	4	4	3	3	3	3	2
	250	4	4	4	3	3	3	2	2	2	2
	300	4	3	3	3	2	2	2	2	2	2
	400	3	3	2	2	2	2	2	1	1	1
	500	2	2	2	2	2	2	1	1	1	1
90	150	11	10	9	8	7	6	6	5	5	5
	200	8	7	6	6	5	5	4	4	4	3
	250	6	6	5	4	4	4	3	3	3	2
	300	5	5	4	4	3	3	3	2	2	2
	400	4	4	3	3	3	2	2	2	2	2
	500	3	3	3	2	2	2	2	2	1	1
95	150	14	12	11	10	9	8	8	7	6	6
	200	10	9	8	7	7	6	5	5	4	4
	250	8	7	6	6	5	5	4	4	3	3
	300	7	6	5	5	4	4	3	3	3	2
	400	5	4	4	4	3	3	3	2	2	2
	500	4	4	3	3	3	2	2	2	2	1
99	150	21	19	17	15	14	12	11	10	10	9
	200	15	13	12	11	10	9	8	7	7	6
	250	12	11	9	8	8	7	6	6	5	4
	300	10	9	8	7	6	6	5	4	4	4
	400	7	7	6	5	5	4	4	3	3	3
	500	6	5	5	4	4	3	3	3	2	2

Table 8-4.

Minehunting/Mechanical Mine Sweeping
Number of Tracks Required (1 Run per Track)

Channel Width (m)	400
SDNE (m)	75

P_{CL}	Characteristic Detection/Cutting Width	Characteristic Detection/Cutting Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	150	4	3	3	3	3	2	2	2	2	2
	200	3	3	2	2	2	2	2	2	2	2
	250	2	2	2	2	2	2	2	1	1	1
	300	2	2	2	2	1	1	1	1	1	1
	400	2	1	1	1	1	1	1	1	1	1
	500	1	1	1	1	1	1	1	1	1	1
60	150	5	4	4	4	3	3	3	3	3	2
	200	4	3	3	3	3	2	2	2	2	2
	250	3	3	2	2	2	2	2	2	2	2
	300	2	2	2	2	2	2	2	1	1	1
	400	2	2	2	1	1	1	1	1	1	1
	500	2	2	1	1	1	1	1	1	1	1
70	150	6	5	5	5	4	4	4	3	3	3
	200	5	4	4	3	3	3	3	3	2	2
	250	4	3	3	3	3	2	2	2	2	2
	300	3	3	3	2	2	2	2	2	2	1
	400	2	2	2	2	2	2	1	1	1	1
	500	2	2	2	2	1	1	1	1	1	1
80	150	8	7	7	6	5	5	5	4	4	4
	200	6	5	5	4	4	4	3	3	3	3
	250	5	4	4	3	3	3	3	3	2	2
	300	4	4	3	3	3	2	2	2	2	2
	400	3	3	2	2	2	2	2	2	1	1
	500	2	2	2	2	2	2	1	1	1	1
90	150	11	10	9	8	8	7	7	6	6	5
	200	8	7	7	6	6	5	5	4	4	4
	250	7	6	5	5	4	4	4	3	3	3
	300	5	5	4	4	4	3	3	3	3	2
	400	4	4	3	3	3	2	2	2	2	2
	500	3	3	3	2	2	2	2	2	2	1
95	150	14	13	12	11	10	9	8	8	7	7
	200	11	9	9	8	7	6	6	6	5	5
	250	8	7	7	6	6	5	5	4	4	4
	300	7	6	5	5	5	4	4	3	3	3
	400	5	5	4	4	3	3	3	3	2	2
	500	4	4	3	3	3	2	2	2	2	2
99	150	22	20	18	16	15	14	13	12	11	10
	200	16	14	13	12	11	10	9	8	6	7
	250	13	11	10	9	8	7	7	6	6	5
	300	10	9	8	7	7	6	6	5	5	4
	400	8	7	6	5	5	4	4	4	3	3
	500	6	5	5	4	4	3	3	3	3	2

Table 8-5.

Minehunting/Mechanical Mine Sweeping
Number of Tracks Required (1 Run per Track)

Channel Width (m)	800
SDNE (m)	10

P_{cal}	Characteristic Detection/Cutting Width	Characteristic Detection/Cutting Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	150	6	5	5	5	4	4	4	4	3	3
	200	5	4	4	4	3	3	3	3	3	3
	250	4	3	3	3	3	3	3	2	2	2
	300	3	3	3	3	2	2	2	2	2	2
	400	3	2	2	2	2	2	2	2	2	2
	500	2	2	2	2	2	2	2	1	1	1
60	150	8	7	6	5	5	5	5	4	4	4
	200	6	5	5	4	4	4	4	3	3	3
	250	5	4	4	3	3	3	3	3	3	3
	300	4	4	3	3	3	3	3	2	2	2
	400	3	3	3	2	2	2	2	2	2	2
	500	3	2	2	2	2	2	2	2	2	2
70	150	10	9	8	7	6	5	5	5	5	4
	200	7	7	6	5	5	4	4	4	4	3
	250	6	5	5	4	4	3	3	3	3	3
	300	5	5	4	4	3	3	3	3	3	2
	400	4	4	3	3	3	2	2	2	2	2
	500	3	3	3	2	2	2	2	2	2	2
80	150	13	11	10	9	8	7	6	6	5	5
	200	10	9	8	7	6	5	5	4	4	4
	250	8	7	6	5	5	4	4	4	3	3
	300	7	6	5	5	4	4	3	3	3	3
	400	5	5	4	4	3	3	3	2	2	2
	500	4	4	3	3	3	2	2	2	2	2
90	150	18	16	14	12	11	10	8	7	6	6
	200	14	12	11	9	8	7	6	5	5	4
	250	11	10	9	8	7	6	5	4	4	4
	300	9	8	7	6	6	5	4	4	3	3
	400	7	6	6	5	4	4	3	3	3	2
	500	6	5	5	4	4	3	3	2	2	2
95	150	24	21	18	16	14	12	11	9	8	6
	200	18	16	14	12	11	9	8	7	6	5
	250	14	13	11	10	9	7	7	6	5	4
	300	12	11	9	8	7	6	6	5	4	3
	400	9	8	7	6	5	5	4	4	3	3
	500	7	7	6	5	4	4	3	3	3	2
99	150	36	32	28	24	21	19	16	14	12	10
	200	27	24	21	18	16	14	12	10	9	7
	250	22	19	17	15	13	11	10	8	7	6
	300	18	16	14	12	11	9	8	7	6	5
	400	14	12	11	9	8	7	6	5	5	4
	500	11	10	9	8	7	6	5	4	4	3

Table 8-6.

Minehunting/Mechanical Mine Sweeping
Number of Tracks Required (1 Run per Track)

Channel Width (m)	800
SDNE (m)	25

P_d	Characteristic Detection/Cutting Width	Characteristic Detection/Cutting Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	150	6	5	5	5	4	4	4	4	3	3
	200	5	4	4	4	3	3	3	3	3	3
	250	4	3	3	3	3	3	3	2	2	2
	300	3	3	3	3	2	2	2	2	2	2
	400	3	2	2	2	2	2	2	2	2	2
	500	2	2	2	2	2	2	2	1	1	1
60	150	8	7	6	6	5	5	5	4	4	4
	200	6	5	5	4	4	4	4	3	3	3
	250	5	4	4	3	3	3	3	3	3	3
	300	4	4	3	3	3	3	3	2	2	2
	400	3	3	3	2	2	2	2	2	2	2
	500	3	2	2	2	2	2	2	2	2	2
70	150	10	9	8	7	6	6	5	5	5	4
	200	8	7	6	5	5	4	4	4	4	3
	250	6	5	5	4	4	3	3	3	3	3
	300	5	5	4	4	3	3	3	3	3	2
	400	4	4	3	3	3	2	2	2	2	2
	500	3	3	3	2	2	2	2	2	2	2
80	150	14	12	11	9	8	8	7	6	5	5
	200	10	9	8	7	6	6	5	4	4	4
	250	8	7	6	6	5	4	4	4	3	3
	300	7	6	5	5	4	4	3	3	3	3
	400	5	5	4	4	3	3	3	2	2	2
	500	4	4	3	3	3	2	2	2	2	2
90	150	19	17	15	13	12	11	10	8	8	7
	200	14	13	11	10	9	8	7	6	5	5
	250	11	10	9	8	7	6	5	5	4	4
	300	10	8	7	7	6	5	5	4	3	3
	400	7	6	6	5	4	4	3	3	3	2
	500	6	5	5	4	4	3	3	2	2	2
95	150	25	22	19	17	15	14	12	11	10	8
	200	18	16	14	13	11	10	9	8	7	6
	250	15	13	11	10	9	8	7	6	5	4
	300	12	11	9	8	7	7	6	5	4	4
	400	9	8	7	6	6	5	4	4	3	3
	500	7	7	6	5	5	4	4	3	3	2
99	150	38	33	30	26	23	21	19	16	15	13
	200	28	25	22	19	17	15	13	12	10	9
	250	22	19	17	15	13	12	10	9	8	7
	300	19	16	14	13	11	10	9	7	6	5
	400	14	12	11	9	8	7	6	6	5	4
	500	11	10	9	8	7	6	5	4	4	3

Table 8-7.

Minehunting/Mechanical Mine Sweeping
Number of Tracks Required (1 Run per Track)

Channel Width (m)	800
SDNE (m)	50

P	Characteristic Detection/Cutting Width	Characteristic Detection/Cutting Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	150	7	6	5	5	4	4	4	4	3	3
	200	5	4	4	4	3	3	3	3	3	3
	250	4	4	3	3	3	3	3	2	2	2
	300	3	3	3	3	2	2	2	2	2	2
	400	3	2	2	2	2	2	2	2	2	2
	500	2	2	2	2	2	2	2	1	1	1
60	150	9	8	7	6	6	5	5	4	4	4
	200	6	6	5	5	4	4	3	3	3	3
	250	5	5	4	4	3	3	3	3	3	3
	300	4	4	3	3	3	3	3	2	2	2
	400	3	3	3	2	2	2	2	2	2	2
	500	3	2	2	2	2	2	2	2	2	2
70	150	11	10	9	8	7	7	6	6	5	5
	200	8	7	7	6	5	5	4	4	4	3
	250	6	6	5	5	4	4	3	3	3	3
	300	5	5	4	4	3	3	3	3	3	2
	400	4	4	3	3	3	2	2	2	2	2
	500	3	3	3	2	2	2	2	2	2	2
80	150	15	13	12	11	10	9	8	7	7	6
	200	11	10	9	8	7	6	6	5	5	4
	250	8	8	7	6	5	5	4	4	4	3
	300	7	6	6	5	4	4	4	3	3	3
	400	5	5	4	4	3	3	3	2	2	2
	500	4	4	3	3	3	2	2	2	2	2
90	150	21	19	17	15	14	12	11	10	10	9
	200	15	13	12	11	10	9	8	7	7	6
	250	12	11	9	8	8	7	6	6	5	4
	300	10	9	8	7	6	6	5	4	4	4
	400	7	7	6	5	5	4	4	3	3	3
	500	6	5	5	4	4	3	3	3	2	2
95	150	27	24	21	19	18	16	15	13	12	11
	200	20	17	15	14	13	11	10	9	8	8
	250	15	14	12	11	10	9	8	7	6	6
	300	13	11	10	9	8	7	6	6	5	4
	400	9	8	7	7	6	5	5	4	4	3
	500	8	7	6	5	5	4	4	3	3	2
99	150	41	37	33	30	27	24	22	20	19	17
	200	30	26	24	21	19	17	16	14	13	11
	250	23	21	18	16	15	13	12	11	9	8
	300	19	17	15	13	12	11	10	8	8	7
	400	14	13	11	10	9	8	7	6	5	5
	500	11	10	9	8	7	6	5	5	4	4

Table 8-8.

Minehunting/Mechanical Mine Sweeping
Number of Tracks Required (1 Run per Track)

Channel Width (m)	800
SDNE (m)	75

P%	Characteristic Detection/Cutting Width	Characteristic Detection/Cutting Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	150	7	6	6	5	5	4	4	4	4	3
	200	5	5	4	4	4	3	3	3	3	3
	250	4	4	3	3	3	3	3	2	2	2
	300	3	3	3	3	2	2	2	2	2	2
	400	3	2	2	2	2	2	2	2	2	2
	500	2	2	2	2	2	2	2	1	1	1
60	150	9	8	7	7	6	6	5	5	5	4
	200	7	6	5	5	5	4	4	4	3	3
	250	5	5	4	4	4	3	3	3	3	3
	300	4	4	4	3	3	3	3	2	2	2
	400	3	3	3	2	2	2	2	2	2	2
	500	3	2	2	2	2	2	2	2	2	2
70	150	12	10	10	9	8	7	7	6	6	5
	200	9	8	7	6	6	5	5	5	4	4
	250	7	6	5	5	5	4	4	4	3	3
	300	6	5	5	4	4	3	3	3	3	2
	400	4	4	3	3	3	3	2	2	2	2
	500	3	3	3	2	2	2	2	2	2	2
80	150	15	14	13	11	10	10	9	8	8	7
	200	11	10	9	8	8	7	6	6	5	5
	250	9	8	7	6	6	5	5	5	4	4
	300	7	7	6	5	5	4	4	4	3	3
	400	5	5	4	4	4	3	3	3	2	2
	500	4	4	4	3	3	3	2	2	2	2
90	150	22	20	18	16	15	14	13	12	11	10
	200	16	14	13	12	11	10	9	8	8	7
	250	13	11	10	9	8	7	7	6	6	5
	300	10	9	8	7	7	6	6	5	5	4
	400	8	7	6	5	5	4	4	4	3	3
	500	6	5	5	4	4	3	3	3	3	2
95	150	28	25	23	21	19	17	16	15	14	13
	200	21	18	17	15	14	12	11	11	10	9
	250	16	14	13	12	11	10	9	8	7	7
	300	13	12	10	9	9	8	7	6	6	5
	400	10	9	8	7	6	6	5	5	4	4
	500	8	7	6	5	5	4	4	4	3	3
99	150	43	39	35	32	29	27	25	23	21	20
	200	31	28	25	23	21	19	17	16	15	13
	250	25	22	19	18	16	14	13	12	11	10
	300	20	18	16	14	13	12	11	10	9	8
	400	15	13	12	10	9	8	7	7	6	5
	500	12	10	9	8	7	6	6	5	5	4

Table 8-9.

Influence Mine Sweeping
(Required Number of Tracks/Number of Runs per Track)

Channel Width (m)	400
SDNE (m)	10
Max. Ship Count	5

P_{cai}	Characteristic Actuation Width	Characteristic Actuation Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	100	6/7	6/6	6/6	6/5	6/5	6/5	6/4	6/4	6/4	6/4
	150	5/6	5/5	5/5	5/5	5/4	5/4	5/4	5/4	5/3	5/3
	200	4/6	4/5	4/5	4/4	4/4	4/4	4/4	4/3	4/3	4/3
	250	3/6	3/6	3/5	3/5	3/5	3/4	3/4	3/4	3/4	3/4
	300	3/5	3/5	3/5	3/4	3/4	3/4	3/4	3/3	3/3	3/3
60	100	6/8	6/7	6/6	6/6	6/5	6/5	6/5	6/4	6/4	6/4
	150	5/6	5/6	5/5	5/5	5/5	5/4	5/4	5/4	5/4	5/3
	200	4/6	4/6	4/5	4/5	4/4	4/4	4/4	4/4	4/3	4/3
	250	3/7	3/6	3/6	3/5	3/5	3/4	3/4	3/4	3/4	3/4
	300	3/6	3/5	3/5	3/5	3/4	3/4	3/4	3/3	3/3	3/3
70	100	6/8	6/7	6/7	6/6	6/6	6/5	6/5	6/5	6/4	6/4
	150	5/7	5/6	5/6	5/5	5/5	5/4	5/4	5/4	5/4	5/3
	200	4/7	4/6	4/6	4/5	4/5	4/4	4/4	4/4	4/4	4/3
	250	3/7	3/7	3/6	3/6	3/5	3/5	3/4	3/4	3/4	3/4
	300	3/6	3/6	3/5	3/5	3/5	3/4	3/4	3/4	3/3	3/3
80	100	6/9	6/8	6/7	6/7	6/6	6/6	6/5	6/5	6/5	6/4
	150	5/8	5/7	5/6	5/6	5/5	5/5	5/4	5/4	5/4	5/4
	200	4/7	4/7	4/6	4/6	4/5	4/5	4/4	4/4	4/4	4/4
	250	3/8	3/7	3/7	3/6	3/6	3/5	3/4	3/4	3/4	3/4
	300	3/7	3/6	3/6	3/5	3/5	3/5	3/4	3/4	3/4	3/3
90	100	6/10	6/9	6/8	6/8	6/7	6/6	6/6	6/6	6/5	6/5
	150	5/9	5/8	5/7	5/6	5/6	5/5	5/5	5/5	5/4	5/4
	200	4/8	4/8	4/7	4/6	4/6	4/5	4/5	4/4	4/4	4/4
	250	3/9	3/8	3/7	3/7	3/6	3/6	3/5	3/5	3/4	3/4
	300	3/8	3/7	3/7	3/6	3/5	3/5	3/5	3/4	3/4	3/4
95	100	6/12	6/10	6/9	6/8	6/8	6/7	6/6	6/6	6/5	6/5
	150	5/10	5/9	5/8	5/7	5/6	5/6	5/5	5/5	5/4	5/4
	200	4/9	4/8	4/8	4/7	4/6	4/6	4/5	4/5	4/4	4/4
	250	3/10	3/9	3/8	3/8	3/7	3/6	3/6	3/5	3/5	3/4
	300	3/9	3/8	3/7	3/7	3/6	3/5	3/5	3/5	3/4	3/4
99	100	6/14	6/13	6/11	6/10	6/9	6/8	6/8	6/7	6/6	6/6
	150	5/12	5/10	5/9	5/8	5/8	5/7	5/6	5/6	5/5	5/5
	200	4/11	4/10	4/9	4/8	4/7	4/7	4/6	4/6	4/5	4/4
	250	3/13	3/11	3/10	3/9	3/8	3/7	3/7	3/6	3/5	3/5
	300	3/11	3/10	3/9	3/8	3/7	3/6	3/6	3/5	3/5	3/4

Table 8-10.

Influence Mine Sweeping
(Required Number of Tracks/Number of Runs per Track)

Channel Width (m)	400
SDNE (m)	25
Max. Ship Count	5

P_{cal}	Characteristic Actuation Width	Characteristic Actuation Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	100	4/10	4/9	4/9	4/8	4/7	4/7	4/6	4/6	4/6	4/6
	150	4/7	4/7	4/6	4/6	4/6	4/5	4/5	4/4	4/4	4/4
	200	3/7	3/7	3/6	3/6	3/5	3/5	3/5	3/4	3/4	3/4
	250	3/6	3/6	3/5	3/5	3/5	3/4	3/4	3/4	3/4	3/4
	300	2/8	2/7	2/7	2/6	2/6	2/5	2/5	2/5	2/4	2/4
60	100	4/11	4/10	4/9	4/9	4/8	4/7	4/7	4/7	4/6	4/6
	150	4/8	4/7	4/7	4/6	4/6	4/5	4/5	4/5	4/4	4/4
	200	3/8	3/7	3/7	3/6	3/6	3/5	3/5	3/5	3/4	3/4
	250	3/7	3/6	3/6	3/5	3/5	3/5	3/4	3/4	3/4	3/4
	300	2/9	2/8	2/7	2/7	2/6	2/8	2/5	2/5	2/5	2/4
70	100	4/12	4/11	4/10	4/9	4/9	4/8	4/7	4/7	4/7	4/6
	150	4/9	4/8	4/7	4/7	4/6	4/6	4/5	4/5	4/5	4/4
	200	3/9	3/8	3/7	3/7	3/6	3/6	3/5	3/5	3/5	3/4
	250	3/7	3/7	3/6	3/6	3/5	3/5	3/5	3/4	3/4	3/4
	300	2/9	2/8	2/8	2/7	2/7	2/6	2/6	2/5	2/5	2/5
80	100	4/14	4/12	4/11	4/10	4/10	4/9	4/8	4/8	4/7	4/7
	150	4/10	4/9	4/8	4/7	4/7	4/6	4/6	4/5	4/5	4/5
	200	3/10	3/9	3/8	3/7	3/7	3/6	3/6	3/5	3/5	3/5
	250	3/8	3/7	3/7	3/6	3/6	3/5	3/5	3/5	3/4	3/4
	300	2/10	2/9	2/9	2/8	2/7	2/7	2/6	2/6	2/5	2/5
90	100	4/16	4/14	4/13	4/12	4/11	4/10	4/9	4/9	4/8	4/8
	150	4/11	4/10	4/9	4/8	4/8	4/7	4/6	4/6	4/6	4/5
	200	3/11	3/10	3/9	3/8	3/8	3/7	3/6	3/6	3/5	3/5
	250	3/9	3/8	3/8	3/7	3/6	3/6	3/5	3/5	3/5	3/4
	300	2/12	2/11	2/10	2/9	2/8	2/7	2/7	2/6	2/6	2/5
95	100	4/18	4/16	4/14	4/13	4/12	4/11	4/10	4/10	4/9	4/8
	150	4/12	4/11	4/10	4/9	4/8	4/8	4/7	4/7	4/6	4/6
	200	3/13	3/11	3/10	3/9	3/8	3/8	3/7	3/7	3/6	3/5
	250	3/10	3/9	3/8	3/8	3/7	3/6	3/6	3/5	3/5	3/5
	300	2/13	2/12	2/11	2/10	2/9	2/8	2/7	2/7	2/6	2/6
99	100	4/22	4/20	4/18	4/16	4/15	4/13	4/12	4/11	4/11	4/10
	150	4/15	4/13	4/12	4/11	4/10	4/9	4/8	4/8	4/7	4/6
	200	3/15	3/14	3/12	3/11	3/10	3/9	3/8	3/8	3/7	3/6
	250	3/13	3/11	3/10	3/9	3/8	3/8	3/7	3/6	3/6	3/5
	300	2/16	2/14	2/13	2/12	2/10	2/9	2/9	2/8	2/7	2/6

Table 8-11.

Influence Mine Sweeping
(Required Number of Tracks/Number of Runs per Track)

Channel Width (m)	400
SDNE (m)	50
Max. Ship Count	5

P_{cal}	Characteristic Actuation Width	Characteristic Actuation Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	100	3/14	3/13	3/12	3/11	3/10	3/10	3/9	3/8	3/8	3/8
	150	3/10	3/9	3/8	3/8	3/7	3/7	3/6	3/6	3/6	3/5
	200	2/11	2/10	2/9	2/8	2/8	2/7	2/7	2/6	2/6	2/6
	250	2/9	2/8	2/8	2/7	2/7	2/6	2/6	2/6	2/5	2/5
	300	2/8	2/7	2/7	2/6	2/6	2/6	2/5	2/5	2/5	2/4
60	100	3/16	3/14	3/13	3/12	3/11	3/10	3/10	3/9	3/9	3/8
	150	3/11	3/10	3/9	3/8	3/8	3/7	3/7	3/6	3/6	3/6
	200	2/12	2/11	2/10	2/9	2/8	2/8	2/7	2/7	2/7	2/6
	250	2/10	2/9	2/8	2/8	2/7	2/7	2/6	2/6	2/6	2/5
	300	2/9	2/8	2/7	2/7	2/6	2/6	2/6	2/5	2/5	2/5
70	100	3/17	3/16	3/14	3/13	3/12	3/12	3/11	3/10	3/10	3/9
	150	3/12	3/11	3/10	3/9	3/8	3/8	3/7	3/7	3/7	3/6
	200	2/13	2/12	2/11	2/10	2/9	2/9	2/8	2/7	2/7	2/7
	250	2/11	2/10	2/9	2/8	2/8	2/7	2/7	2/6	2/6	2/6
	300	2/10	2/9	2/8	2/7	2/7	2/6	2/6	2/6	2/5	2/5
80	100	3/20	3/18	3/16	3/15	3/14	3/13	3/12	3/11	3/11	3/10
	150	3/13	3/12	3/11	3/10	3/9	3/9	3/8	3/8	3/7	3/7
	200	2/15	2/13	2/12	2/11	2/10	2/9	2/9	2/8	2/8	2/7
	250	2/12	2/11	2/10	2/9	2/9	2/8	2/7	2/7	2/6	2/6
	300	2/11	2/10	2/9	2/8	2/7	2/7	2/6	2/6	2/6	2/5
90	100	3/23	3/21	3/19	3/17	3/16	3/15	3/14	3/13	3/12	3/11
	150	3/16	3/14	3/13	3/12	3/11	3/10	3/9	3/9	3/8	3/8
	200	2/17	2/15	2/14	2/13	2/12	2/11	2/10	2/9	2/9	2/8
	250	2/14	2/13	2/12	2/11	2/10	2/9	2/8	2/8	2/7	2/7
	300	2/12	2/11	2/10	2/9	2/8	2/8	2/7	2/7	2/6	2/6
95	100	3/26	3/23	3/21	3/20	3/18	3/17	3/16	3/15	3/14	3/13
	150	3/18	3/16	3/14	3/13	3/12	3/11	3/10	3/10	3/9	3/8
	200	2/19	2/17	2/15	2/14	2/13	2/12	2/11	2/10	2/9	2/9
	250	2/16	2/14	2/13	2/12	2/11	2/10	2/9	2/8	2/8	2/7
	300	2/14	2/12	2/11	2/10	2/9	2/9	2/8	2/7	2/7	2/6
99	100	3/32	3/29	3/26	3/24	3/22	3/21	3/19	3/18	3/17	3/16
	150	3/22	3/20	3/18	3/16	3/15	3/14	3/13	3/12	3/11	3/10
	200	2/23	2/21	2/19	2/17	2/16	2/14	2/13	2/12	2/11	2/10
	250	2/20	2/18	2/16	2/14	2/13	2/12	2/11	2/10	2/9	2/8
	300	2/17	2/15	2/14	2/12	2/11	2/10	2/9	2/9	2/8	2/7

Table 8-12.

Influence Mine Sweeping
(Required Number of Tracks/Number of Runs per Track)

Channel Width (m)	400
SDNE (m)	75
Max. Ship Count	5

P_{cal}	Characteristic Actuation Width	Characteristic Actuation Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	100	2/22	2/20	2/18	2/17	2/16	2/15	2/14	2/13	2/12	2/12
	150	2/15	2/14	2/13	2/12	2/11	2/10	2/10	2/9	2/9	2/8
	200	2/12	2/11	2/10	2/9	2/9	2/8	2/8	2/7	2/7	2/6
	250	2/10	2/9	2/8	2/8	2/7	2/7	2/6	2/6	2/6	2/5
	300	2/9	2/8	2/7	2/7	2/6	2/6	2/5	2/5	2/5	2/5
60	100	2/24	2/22	2/20	2/19	2/17	2/16	2/15	2/14	2/14	2/13
	150	2/17	2/15	2/14	2/13	2/12	2/11	2/10	2/10	2/9	2/9
	200	2/13	2/12	2/11	2/10	2/9	2/9	2/8	2/8	2/7	2/7
	250	2/11	2/10	2/9	2/8	2/8	2/7	2/7	2/6	2/6	2/6
	300	2/9	2/9	2/8	2/7	2/7	2/6	2/6	2/6	2/5	2/5
70	100	2/27	2/25	2/23	2/21	2/19	2/18	2/17	2/16	2/15	2/14
	150	2/19	2/17	2/15	2/14	2/13	2/12	2/11	2/11	2/10	2/10
	200	2/14	2/13	2/12	2/11	2/10	2/9	2/9	2/8	2/8	2/7
	250	2/12	2/11	2/10	2/9	2/8	2/8	2/7	2/7	2/6	2/6
	300	2/10	2/9	2/9	2/8	2/7	2/7	2/6	2/6	2/6	2/5
80	100	2/31	2/28	2/25	2/23	2/22	2/20	2/19	2/18	2/17	2/16
	150	2/21	2/19	2/17	2/16	2/15	2/14	2/13	2/12	2/11	2/11
	200	2/16	2/15	2/13	2/12	2/11	2/11	2/10	2/9	2/9	2/8
	250	2/13	2/12	2/11	2/10	2/9	2/9	2/8	2/6	2/7	2/7
	300	2/11	1/10	2/9	2/9	2/8	2/7	2/7	2/6	2/6	2/6
90	100	2/36	2/33	2/30	2/27	2/25	2/24	2/22	2/21	2/19	2/18
	150	2/24	2/22	2/20	2/18	2/17	2/16	2/15	2/14	2/13	2/12
	200	2/19	2/17	2/15	2/14	2/17	2/12	2/11	2/10	2/10	2/9
	250	2/15	2/14	2/13	2/12	2/11	2/10	2/9	2/9	2/8	2/7
	300	2/13	2/12	2/11	2/10	2/9	2/8	2/8	2/7	2/7	2/6
95	100	2/41	2/37	2/34	2/31	2/29	2/27	2/25	2/23	2/22	2/21
	150	2/28	2/25	2/23	2/21	2/19	2/18	2/17	2/15	2/15	2/14
	200	2/21	2/19	2/17	2/16	2/15	2/14	2/13	2/12	2/11	2/10
	250	2/17	2/16	2/14	2/13	2/12	2/11	2/10	2/9	2/9	2/8
	300	2/15	2/13	2/12	2/11	2/10	2/9	2/9	2/8	2/7	2/7
99	100	2/51	2/46	2/42	2/39	2/36	2/33	2/31	2/29	2/27	2/26
	150	2/34	2/31	2/28	2/26	2/24	2/22	2/20	2/19	2/18	2/17
	200	2/26	2/24	2/21	2/20	2/18	2/17	2/15	2/14	2/13	2/12
	250	2/21	2/19	2/17	2/16	2/15	2/13	2/12	2/11	2/11	2/10
	300	2/18	2/16	2/15	2/13	2/12	2/11	2/10	2/10	2/9	2/8

Table 8-13.

Influence Mine Sweeping
(Required Number of Tracks/Number of Runs per Track)

Channel Width (m)	800
SDNE (m)	10
Max. Ship Count	5

P_{cal}	Characteristic Actuation Width	Characteristic Actuation Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	100	12/7	12/6	12/6	12/5	12/5	12/5	12/4	12/4	12/4	12/4
	150	9/6	9/6	9/5	9/5	9/4	9/4	9/4	9/4	9/4	9/4
	200	7/6	7/5	7/5	7/5	7/4	7/4	7/4	7/4	7/4	7/4
	250	6/6	6/5	6/5	6/4	6/4	6/4	6/4	6/3	6/3	6/3
	300	5/6	5/5	5/5	5/5	5/4	5/4	5/4	5/4	5/3	5/3
60	100	12/7	12/7	12/6	12/6	12/5	12/5	12/5	12/4	12/4	12/4
	150	9/7	9/6	9/6	9/5	9/5	9/4	9/4	9/4	9/4	9/4
	200	7/6	7/6	7/5	7/5	7/5	7/4	7/4	7/4	7/4	7/4
	250	6/6	6/6	6/5	6/5	6/4	6/4	6/4	6/4	6/3	6/3
	300	5/6	5/6	5/5	5/5	5/4	5/4	5/4	5/4	5/3	5/3
70	100	12/8	12/7	12/7	12/6	12/6	12/5	12/5	12/5	12/4	12/4
	150	9/7	9/7	9/6	9/5	9/5	9/5	9/4	9/4	9/4	9/4
	200	7/7	7/6	7/6	7/5	7/5	7/5	7/4	7/4	7/4	7/4
	250	6/7	6/6	6/6	6/5	6/5	6/4	6/4	6/4	6/4	6/3
	300	5/7	5/6	5/6	5/5	5/5	5/4	5/4	5/4	5/4	5/3
80	100	12/9	12/8	12/7	12/7	12/6	12/6	12/5	12/5	12/4	12/4
	150	9/8	9/7	9/7	9/6	9/6	9/5	9/5	9/4	9/4	9/4
	200	7/8	7/7	7/6	7/6	7/5	7/5	7/5	7/4	7/4	7/4
	250	6/7	6/7	6/6	6/6	6/5	6/5	6/4	6/4	6/4	6/4
	300	5/8	5/7	5/6	5/6	5/5	5/5	5/4	5/4	5/4	5/4
90	100	12/10	12/9	12/8	12/7	12/7	12/6	12/6	12/5	12/5	12/5
	150	9/9	9/8	9/7	9/7	9/6	9/6	9/5	9/5	9/4	9/4
	200	7/9	7/8	7/7	7/7	7/6	7/6	7/5	7/5	7/4	7/4
	250	6/8	6/8	6/7	6/6	6/6	6/5	6/5	6/4	6/4	6/4
	300	5/9	5/8	5/7	5/6	5/6	5/5	5/5	5/5	5/4	5/4
95	100	12/11	12/10	12/9	12/8	12/8	12/7	12/6	12/6	12/5	12/5
	150	9/10	9/9	9/8	9/7	9/7	9/6	9/6	9/5	9/5	9/4
	200	7/10	7/9	7/8	7/7	7/7	7/6	7/6	7/5	7/5	7/4
	250	6/9	6/8	6/8	6/7	6/6	6/6	6/5	6/5	6/4	6/4
	300	5/10	5/9	5/8	5/7	5/6	5/6	5/5	5/5	5/4	5/4
99	100	12/14	12/12	12/11	12/10	12/9	12/8	12/7	12/7	12/6	12/6
	150	9/12	9/11	9/10	9/9	9/8	9/7	9/7	9/6	9/5	9/5
	200	7/12	7/11	7/10	7/9	7/8	7/7	7/6	7/6	7/5	7/5
	250	6/11	6/10	6/9	6/8	6/7	6/7	6/6	6/6	6/5	6/4
	300	5/12	5/10	5/9	5/8	5/8	5/7	5/6	5/6	5/5	5/5

Table 8-14.

Influence Mine Sweeping
(Required Number of Tracks/Number of Runs per Track)

Channel Width (m)	800
SDNE (m)	25
Max. Ship Count	5

P_{cal}	Characteristic Actuation Width	Characteristic Actuation Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	100	8/10	8/9	8/8	8/8	8/7	8/7	8/6	8/6	8/6	8/5
	150	7/8	7/7	7/7	7/6	7/6	7/5	7/5	7/5	7/4	7/4
	200	6/7	6/6	6/6	6/5	6/5	6/5	6/4	6/4	6/4	6/4
	250	5/7	5/6	5/6	5/5	5/5	5/5	5/4	5/4	5/4	5/4
	300	4/7	4/6	4/6	4/6	4/5	4/5	4/5	4/4	4/4	4/4
60	100	8/11	8/10	8/9	8/8	8/8	8/7	8/7	8/6	8/6	8/6
	150	7/8	7/8	7/7	7/6	7/6	7/6	7/5	7/5	7/5	7/4
	200	6/8	6/7	6/6	6/6	6/5	6/5	6/5	6/4	6/4	6/4
	250	5/7	5/7	5/6	5/6	5/5	5/5	5/5	5/4	5/4	5/4
	300	4/8	4/7	4/6	4/6	4/5	4/5	4/5	4/5	4/4	4/4
70	100	8/12	8/11	8/10	8/9	8/8	8/8	8/7	8/7	8/6	8/6
	150	7/9	7/8	7/8	7/7	7/7	7/6	7/6	7/5	7/5	7/5
	200	6/8	6/7	6/7	6/6	6/6	6/5	6/5	6/5	6/4	6/4
	250	5/8	5/7	5/7	5/6	5/6	5/5	5/5	5/5	5/4	5/4
	300	4/8	4/8	4/7	4/6	4/6	4/5	4/5	4/5	4/4	4/4
80	100	8/13	8/12	8/11	8/10	8/9	8/9	8/8	8/7	8/7	8/7
	150	7/10	7/9	7/8	7/8	7/7	7/7	7/6	7/6	7/5	7/5
	200	6/9	6/8	6/7	6/7	6/6	6/6	6/5	6/5	6/5	6/4
	250	5/9	5/8	5/7	5/7	5/6	5/6	5/5	5/5	5/5	5/4
	300	4/9	4/8	4/8	4/7	4/6	4/6	4/5	4/5	4/5	4/4
90	100	8/15	8/14	8/13	8/11	8/11	8/10	8/9	8/8	8/8	8/7
	150	7/12	7/11	7/10	7/9	7/8	7/7	7/7	7/6	7/6	7/5
	200	6/10	6/9	6/9	6/8	6/7	6/7	6/6	6/6	6/5	6/5
	250	5/10	5/9	5/8	5/8	5/7	5/6	5/6	5/5	5/5	5/5
	300	4/11	4/10	4/9	4/8	4/7	4/7	4/6	4/5	4/5	4/5
95	100	8/17	8/15	8/14	8/13	8/12	8/11	8/10	8/9	8/9	8/8
	150	7/13	7/12	7/11	7/10	7/9	7/8	7/8	7/7	7/6	7/6
	200	6/12	6/10	6/9	6/9	6/8	6/7	6/7	6/6	6/6	6/5
	250	5/11	5/10	5/9	5/8	5/8	5/7	5/6	5/6	5/5	5/5
	300	4/12	4/11	4/10	4/9	4/8	4/7	4/7	4/6	4/6	4/5
99	100	8/21	8/19	8/17	8/16	8/14	8/13	8/12	8/11	8/10	8/10
	150	7/16	7/14	7/13	7/12	7/11	7/10	7/9	7/8	7/7	7/7
	200	6/14	6/13	6/11	6/10	6/9	6/9	6/8	6/7	6/6	6/6
	250	5/14	5/12	5/11	5/10	5/9	5/8	5/8	5/7	5/6	5/6
	300	4/15	4/13	4/12	4/10	4/9	4/9	4/8	4/7	4/6	4/6

Table 8-15.

Influence Mine Sweeping
(Required Number of Tracks/Number of Runs per Track)

Channel Width (m)	800
SDNE (m)	50
Max. Ship Count	5

P_{cal}	Characteristic Actuation Width	Characteristic Actuation Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	100	6/13	6/12	6/11	6/10	6/10	6/9	6/9	6/8	6/8	6/7
	150	5/11	5/10	5/9	5/8	5/8	5/7	5/7	5/6	5/6	5/8
	200	4/10	4/9	4/9	4/8	4/7	4/7	4/6	4/6	4/6	4/5
	250	4/8	4/8	4/7	4/7	4/6	4/6	4/5	4/5	4/5	4/5
	300	4/7	4/7	4/6	4/6	4/5	4/5	4/5	4/4	4/4	4/4
60	100	6/15	6/13	6/12	6/11	6/11	6/10	6/9	6/9	6/8	6/8
	150	5/12	5/11	5/10	5/9	5/9	5/8	5/7	5/7	5/7	5/6
	200	4/11	4/10	4/9	4/9	4/8	4/7	4/7	4/7	4/6	4/6
	250	4/9	4/8	4/8	4/7	4/7	4/6	4/6	4/5	4/5	4/5
	300	4/8	4/7	4/7	4/6	4/6	4/5	4/5	4/5	4/4	4/4
70	100	6/16	6/15	6/14	6/13	6/12	6/11	6/10	6/10	6/9	6/9
	150	5/13	5/12	5/11	5/10	5/9	5/9	5/8	5/8	5/7	5/7
	200	4/12	4/11	4/10	4/9	4/9	4/8	4/7	4/7	4/7	4/6
	250	4/10	4/9	4/8	4/8	4/7	4/7	4/6	4/6	4/5	4/5
	300	4/9	4/8	4/7	4/7	4/6	4/6	4/5	4/5	4/5	4/4
80	100	6/18	6/17	6/15	6/14	6/13	6/12	6/11	6/11	6/10	6/9
	150	5/15	5/13	5/12	5/11	5/10	5/10	5/9	5/8	5/8	5/7
	200	4/14	4/12	4/11	4/10	4/10	4/9	4/8	4/8	4/7	4/7
	250	4/11	4/10	4/9	4/8	4/8	4/7	4/7	4/6	4/6	4/5
	300	4/10	4/9	4/8	4/7	4/7	4/6	4/6	4/5	4/5	4/5
90	100	6/22	6/20	6/18	6/16	6/15	6/14	6/13	6/12	6/11	6/11
	150	5/17	5/15	5/14	5/13	5/12	5/11	5/10	5/9	5/9	5/8
	200	4/16	4/14	4/13	4/12	4/11	4/10	4/9	4/9	4/8	4/8
	250	4/13	4/12	4/11	4/10	4/9	4/8	4/8	4/7	4/7	4/6
	300	4/11	4/10	4/9	4/8	4/8	4/7	4/6	4/6	4/6	4/5
95	100	6/24	6/22	6/20	6/18	6/17	6/16	6/15	6/14	6/13	6/12
	150	5/19	5/17	5/16	5/14	5/13	5/12	5/11	5/11	5/10	5/9
	200	4/18	5/16	4/14	4/13	4/12	4/11	4/10	4/10	4/9	4/8
	250	4/15	4/13	4/12	4/11	4/10	4/9	4/8	4/8	4/7	4/7
	300	4/12	4/11	4/10	4/9	4/8	4/8	4/7	4/7	4/6	4/6
99	100	6/30	6/27	6/25	6/23	6/21	6/19	6/18	6/17	6/16	6/15
	150	5/24	5/21	5/19	5/18	5/16	5/15	5/14	5/13	5/12	5/11
	200	4/22	4/20	4/18	4/16	4/15	4/13	4/12	4/11	4/11	4/10
	250	4/18	4/16	4/14	4/13	4/12	4/11	4/10	4/9	4/8	4/8
	300	4/15	4/13	4/12	4/11	4/10	4/9	4/8	4/8	4/7	4/6

Table 8-16.

Influence Mine Sweeping
(Required Number of Tracks/Number of Runs per Track)

Channel Width (m)	800
SDNE (m)	75
Max. Ship Count	5

P_{cal}	Characteristic Actuation Width	Characteristic Actuation Probability									
		0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
50	100	4/20	4/19	4/17	4/16	4/15	4/14	4/13	4/12	4/11	4/11
	150	4/14	4/13	4/12	4/11	4/10	4/9	4/9	4/8	4/8	4/7
	200	4/11	4/10	4/9	4/8	4/8	4/7	4/7	4/6	4/6	4/6
	250	3/11	3/10	3/9	3/9	3/8	3/8	3/7	3/7	[illegible]	3/6
	300	3/10	3/9	3/8	3/7	3/7	3/6	3/6	3/6	3/5	3/5
60	100	4/23	4/20	4/19	4/17	4/16	4/15	4/14	4/13	4/13	4/12
	150	4/15	4/14	4/13	4/12	4/11	4/10	4/10	4/9	4/8	4/8
	200	4/12	4/11	4/10	4/9	4/8	4/6	4/7	4/7	4/6	4/6
	250	3/12	3/11	3/10	3/9	3/9	3/8	3/8	3/7	3/7	3/6
	300	3/10	3/10	3/9	3/8	3/7	3/7	3/7	3/6	3/6	3/5
70	100	4/25	4/23	4/21	4/19	4/18	4/17	4/16	4/15	4/14	4/13
	150	4/17	4/15	4/14	4/13	4/12	4/11	4/11	4/10	4/9	4/9
	200	4/13	4/12	4/11	4/10	4/9	4/9	4/8	4/7	4/7	4/7
	250	3/13	3/12	3/11	3/10	3/9	3/9	3/8	3/8	3/7	3/7
	300	3/12	3/10	3/10	3/9	3/8	3/8	3/7	3/7	3/6	3/6
80	100	4/28	4/26	4/24	4/22	4/20	4/19	4/17	4/16	4/15	4/15
	150	4/19	4/17	4/16	4/14	4/13	4/12	4/12	4/11	4/10	4/10
	200	4/14	4/13	4/12	4/11	4/10	4/9	4/9	4/8	4/8	4/7
	250	3/15	3/14	3/12	3/11	3/11	3/10	3/9	3/8	3/8	3/7
	300	3/13	3/12	3/11	3/10	3/9	3/8	3/8	3/7	3/7	3/6
90	100	4/33	4/30	4/28	4/25	4/23	4/22	4/20	4/19	4/18	4/17
	150	4/22	4/20	4/18	4/17	4/16	4/14	4/13	4/13	4/12	4/11
	200	4/17	4/15	4/14	4/13	4/12	4/11	4/10	4/9	4/9	4/8
	250	3/17	3/16	3/14	3/13	3/12	3/11	3/11	3/10	3/9	3/8
	300	3/15	3/13	3/12	3/11	3/10	3/9	3/9	3/8	3/8	3/7
95	100	4/38	4/34	4/31	4/29	4/27	4/25	4/23	4/22	4/20	4/19
	150	4/25	4/23	4/21	4/19	4/18	4/16	4/15	4/14	4/13	4/12
	200	4/19	4/17	4/16	4/14	4/13	4/12	4/11	4/10	4/10	4/9
	250	3/20	3/18	3/16	3/15	3/13	3/12	3/12	3/11	3/10	3/9
	300	3/17	3/15	3/14	3/12	3/11	3/10	3/10	3/9	3/8	3/8
99	100	4/47	4/43	4/39	4/36	4/33	4/31	4/29	4/27	4/25	4/24
	150	4/31	4/28	4/26	4/24	4/22	4/20	4/19	4/17	4/16	4/15
	200	4/23	4/21	4/19	4/17	4/16	4/15	4/14	4/13	4/12	4/11
	250	3/24	3/22	3/20	3/18	3/16	3/15	3/14	3/13	3/12	3/11
	300	3/21	3/18	3/17	3/15	3/14	3/13	3/12	3/11	3/10	3/9

Table 8-17.

0825 - 0829. SPARE

SECTION 4

EXPLORATORY OPERATIONS

0830. GENERAL

a. Definitions and principles of an exploratory operation

(1) The aim of an exploratory operation is to determine the presence or absence of mines in a channel/area.

(2) Principles :

The decision to carry out an exploratory operation rests with the OPCON authority. He should specify the percentage clearance to be achieved.

b. Execution of an exploratory operation

(1) Unless otherwise ordered the exploratory operation is executed in uniform coverage.

(2) The sweeping or hunting of a mine does not complete the operation, an effort over the complete channel/area in consideration will allow the localization of the focal or critical mined areas.

0831. PLANNING AN EXPLORATY OPERATION

a. Introduction

Care should be taken into the distribution of effort when different techniques are available for the execution of the operation. Runs can be allocated between identical techniques while between different ones the allocation is done by "coverages".

The effort already put into the channel/area during the exploratory (for the minetype into consideration) should be taken into account when planning further MCM operations.

b. Rule for determination of the effort

To determine the effort required (expressed in percentage clearance) use tables in section 3 of this chapter.

c. Optimum division of combined MCM techniques in the same channel/area

If different MCM techniques are available to execute an exploratory operation, the optimum division of effort between the techniques (combined MCM techniques) in the same channel/

area will improve the result of the operation (determine the presence or absence of mine(s)). In order to optimize this division it will be sensible to "target" the operation against the mines most likely to be present.

d. Reducing the risk (R) to MCMV

In order to reduce the risk the methods described in section 2 of this chapter apply.

0832. EVALUATION OF AN EXPLORATORY OPERATION

a. Introduction

(1) After carrying out an exploratory operation there are two possible results: one or more mines are countered or no mines are countered during the operation.

(2) More over, by "exploring" a channel/area, it is possible to localise those areas in which mines are most likely to be present thereby reducing the size of the channel(s)/area(s) for further MCM operations.

(3) When evaluating an exploratory operation care should be taken in not mixing conclusions drawn from channel(s)/area(s) where different parameter values were used to plan the operation.

b. Considerations

If no mine was swept or hunted it should be borne in mind that the following possibilities do exist :

(1) There are no mines in the area.

(2) The sweep is not working properly.

(3) The mines are all on high ship-counts or not armed.

(4) An incorrect technique is being used.

(5) The mine is not responding to the influence provided by the sweep.

(6) The environment is unfavourable to sonar detection.

0833 - 0839. SPARE

CHAPTER 9

SAFETY ASPECTS

SECTION 1

SAFETY CONSIDERATIONS IN PLANNING MCM-OPERATIONS

0901. GENERAL

a. The authority responsible for writing the operation order must clearly specify:

(1) The safety distance to be observed between the different MCM units.

(2) The authority responsible for implementing the co-ordinating regulations.

b. Coordinating authority
In principle, the authority conducting the operation (the tasking authority) is also the coordinating authority. When selecting a different coordinator it is generally appropriate to select in the following order:

(1) CTU CONTAINING CLEARANCE DIVER UNITS.

(2) CTU CONTAINING MINEHUNTERS.

(3) CTU CONTAINING MINESWEEPERS.

0902. DIVING SAFETY

Compatibility of compression chambers and diving equipment should be considered. Aspects of diving safety must be covered in the Opord Annex O. (See also EXTAC 1009).

0903. SEARCH AND RESCUE

Local Search and Rescue (SAR) arrangements should be addressed in the Opord Annex O. (See also ATP 10).

0904. SAFETY DISTANCES

The safety distances should be selected taking the following factors into account:

a. Uncertainty regarding the propagation of sound pressure waves due to explosions and acoustic sweeps.

b. The characteristics of the detonating systems for mine disposal charges.

c. Any available information regarding the mine's detonating system.

d. National regulations.

0905. LEADTHROUGH

a. To reduce the risk of actuating an influence mine, a constant slow speed and minimum feasible separation distance between transitors is essential. Only the lead units are to adjust speed to maintain the signalled distance.

b. It is advisable to conduct a Check Operation prior to a leadthrough if the time between completion of MCM and transit of ships is more than 24 hours or an indication of new mining is available.

c. Active MCM will normally not be carried out during leadthrough operations.

d. Although Leadthrough is not a MCM operation, generally a great responsibility is given to the OTC of a MCM force concerning the execution of this special type of maritime operations.

(1) MCMVs or any other capable vessel being familiar with the respective area can have the task of leading through all types of ships and vessels in channels or areas which may have been mined. The aim of leadthrough is to give navigational support to transit ships for staying as close as possible to the centreline of a channel or any track ordered in an area.

(2) Once the OPCON Authority has decided to sail ships through a mined area, the OTC of the force ordered to conduct the leadthrough must endeavour to make the passage as safe as possible. Exchange of information as detailed in messages (see Annex G) is a prerequisite.

(3) For EMCON reasons, the primary method of communications is by light or signal hoist, however, rapid tactical communications by light or flag with merchant vessels is likely to be difficult or impossible. Early transfer of written instructions by boat or heaving line should be considered. It should be noted that few merchant vessels are fitted with UHF but secondary methods should be employed in the following order of preference:

- UHF Voice.

- VHF Voice.

Use can also be made of signal groups from Annex H, and the International Code of Signals. It should be noted that the International flag outfit contains numerical pennants only.

0906. SUPPORT OF MCM OPERATIONS

During operations an MCM force may require AAW, ASU and ASW protection. When operating in mined waters, MCM forces are limited in their ability to manoeuvre in channels and avoiding action cannot be taken before the gear has been recovered. This makes the MCM force vulnerable to enemy attack. Warning should be issued in due time in order to enable the MCM force to take avoiding action. The OTCs must ensure that there is a clear understanding between the two forces as to their relative movements, communications, tactical limitations, etc.

0907 - 0909. SPARE

SECTION 2

SAFETY IN CONDUCTING MCM OPS

0910. FOG

a. In Peacetime

(1) MECHANICAL SWEEPING
The OTC orders sweeps to be recovered, maintaining the sweeping formation.

(2) INFLUENCE SWEEPING
The OTC orders the sweeps to be recovered if he considers it necessary (untrained ships, volume of traffic etc).

b. In Wartime
Operations should be continued as long as safe navigation permits. If the OTC considers that it is not possible to continue the operation, he is to manoeuvre the formation in time for sweeps to be recovered with the maximum safety.

0911. MAN OVERBOARD DURING SWEEPING

a. Measures to be taken immediately
The ship from which a man falls overboard:

(1) Drops a lifebuoy.

(2) De-energizes sweeps (peace time only).

(3) Sounds six short blasts on the whistle.

(4) By day, hoists Flag OSCAR where it can best be seen. By night (in peacetime) displays two flashing red lights arranged vertically, or fires 2 white rockets (or 2 white Very lights).

(5) Reports as rapidly as possible to the OTC and to the ships of the formation.

b. Wheel and Engine manoeuvring
The short length of the MCM vessel and the reduced effect of the rudder while sweeping render manoeuvring with rudder and engines unprofitable for swinging the stern clear of the man overboard and may well endanger the sweep. However, depending on conditions prevailing and operational circumstances permitting, a sweeper can be manoeuvred to recover the man. Provided the water is deep enough to prevent bottoming of the gear, the ship should be turned and brought to rest upwind of the man in the water. A swimmer (with line attached) recovery technique is best adopted for the actual recovery.

0912. EMERGENCY CUTTING OR SLIPPING SWEEPS

Emergency Cutting or Slipping Sweeps. Ships should be prepared at all times to cut or slip sweeps in an emergency situation. National policy should be followed.

0913. MEASURES TO PREVENT MUTUAL INTERFERENCE AND PRINCIPLES GOVERNING PRIORITIES BETWEEN UNITS

a. The measures are not intended to cancel or supersede the International Rules for the Prevention of Collision at Sea. The measures are only to avoid interactions between different MCM-Systems operating in close vicinity. They are not to be used as long as MCMV/Helo are not handling their equipment or diving operations are conducted.

b. To find the right way for one system to another, all systems are divided into the following list of priorities:

Priority	Unit	System
1	MH(D)/MCD	- Minehunter/Clearance diving vessel, while having divers in the water.
2	MH(TSS)	- Minehunter with towed side-scan sonar.
3	MH(RV)	- Minehunter, while operating the drone/remote controlled vehicle in the water.
4	MS(T)	- Minesweepers with streamed team sweep.
5	MS(F)	- Minesweepers in formation with streamed gear.
6	MS(I)	- Minesweeper independent with streamed gear.
7	MSCD	- Minesweeper with drones (TROIKA).
8	MH(H)	- Minehunter, while hunting (no drone/diver in the water).
9	H/C	- MCM - Helicopter with streamed gear.

The unit with the highest priority has the right of way. This unit has to inform the unit with lower priority in case of possible interference in due time. The unit with lower priority must take action to avoid interference.

c. MCM signals and lights are to be shown at all times while minehunting. Diving signals are to be shown only when diving operations are actually in progress. At night, a white light is to be shown by every gemini dinghy during diving operations. During wartime, the use of navigational lights is at the OTC's discretion.

d. Tasking authorities should order a buffer zone of at least 2000 yds between different MCM systems when operating simultaneously in the same objective area.

e. Cooperation between Minehunting Vessels and Divers
Radio communication is required between the minehunters and the minehunting diving craft eg diving dinghies. Minehunters should normally operate independently at least two miles apart to:

(1) Work at the optimum rate.

(2) Eliminate sonar mutual interference.

(3) Reduce the danger to ships and divers due to underwater shock from an unexpected detonation.

f. Safety of Divers from explosions
Careful timing of the use of explosive charges or of the detonation of mines is essential if other forces operating in adjacent areas are not to be endangered. It will normally be easy for diving forces to time the explosion of their charges so that the work of MCM forces in adjacent areas is not interrupted, but minesweeping forces are liable to detonate mines at unpredictable times. To avoid danger to divers employed on mine disposal or recovery a minimum separation should be maintained between divers in the water and minesweepers. The separation should be the sum of the maximum acceptable separation of divers from a mine explosion (see Table 9-1) and the maximum expected range of actuation of the most sensitive mine by the sweep in question. Note that these maximum actuation ranges may be in excess of 5 miles.

TOTAL MASS OF EXPLOSIVE IN TNT EQUIVALENT		DISTANCE IN NAUTICAL MILES
less then	225 kg	3/4 + actuation range
from	225 to 550 kg	1 + actuation range
from	551 to 900 kg	1 1/4 + actuation range
from	901 to 1800 kg	1 1/2 + actuation range

Table 9-1. Minimum Acceptable Separation Distances

0914. SPECIAL SAFETY SUPPORTING SIGNALS IN MINE COUNTERMEASURES

MCM signals are given in Annex D. However, some special signals which only apply for MCMV are listed/described in paras 0915 - 0918 below.

0915. SPECIAL NON-ALPHABETICAL SIGNALS FOR USE IN MCM

a. Black Balls

The black balls referred to in this publication should be between 0.6 and 1.2 metres in diameter.

b. Red Flag

A large red flag is used to indicate the state of magnetic sweeps. The working of this flag is laid down in Table 9-2.

c. Black Flag

The working of the black flag during acoustic sweeping is described in Table 9-2. Ships which do not carry a black flag may use a black pennant with part of the flag cut off to make it as nearly square as possible.

d. Signals for use between bridges when manoeuvring in team sweeping formations

A red or green flag, fitted on a staff, is held up as soon as the wheel is put over when turning to port or starboard respectively; kept up while the ship is turning, then waved and taken down when the ship is steady.

e. Special signals for heave and veer

(1) HEAVE IN
By day : Flag H waved from sweep deck
By night: short white flashes

(2) VEER
By day : Flag V waved from sweep deck
By night: long white flashes

0916. SIGNALS DISPLAYED WHEN SWEEPING

a. In all types of sweeping, 3 black balls are hoisted, one at the masthead and one at each yardarm. They remain close up throughout minesweeping operations, from beginning of streaming to the end of recovery. By night, the black balls are replaced by 3 fitted green lights. The displayed signals are as prescribed by Rule 27f of the International Regulations for Prevention of Collisions at Sea (IRPCS).

b. In influence minesweeping, flags also indicate the type of sweep operated and their status of energizing. A red flag is hoisted whenever magnetic sweeps are energized for sweeping and test pulsing. A black flag is hoisted whenever acoustic sweeps are energized for sweeping or testing.

c. See Table 9-2.

0917. SIGNALS DISPLAYED BY MINEHUNTERS

When engaged in minehunting, minehunters shall display the same shapes and lights as prescribed in rule 27f of international regulations for preventing collisions at sea (IRPCS).

a. Minehunters Operating Divers
The minehunter will display Flag A by day.

b. When approached by another vessel the minehunter shall signal the letter 'U' by flashing light and make a warning sound signal if the approaching vessel does not take avoiding action.

c. See Table 9-3.

0918. SIGNALS DISPLAYED BY DIVING DINGHIES

When operating divers or conducting mine disposal operations, the dinghies:

a. By day
Have to display/be prepared to display flag A or flag B of the international code of signals as appropriate, when approached by other vessels.

b. By night
Are required to display/be prepared to display an all-round white light and are required to be prepared to show a signal to attract attention.

c. See Table 9-3.

TYPE OF SWEEP	SIGNAL	OCCASION	WHERE DISPLAYED	MEANING
Magnetic sweeping	*By day* 3 black balls *By night* 3 green lights	From beginning of streaming to end of recovery	One at mast-head, one at both yard-arms	Sweeping operations in progress
	Red flag	Streaming	Where best seen	
			At dip	Sweep streamed, ready to energise
			Close up	Sweep energised (including de-energised)
		Running	At dip	Sweep temporarily de-energised
		Recovery	At the dip	Sweep de-energised
			Hauled down	Gear dis-connected
Acoustic sweeping	*By day* 3 black balls *By night* 3 green lights	From beginning of streaming to end of recovery	One at mast-head, one at both yard-arms	Sweeping operations in progress
	Black flag	Streaming	Where best seen	
			At dip	Sweep streamed, ready to energise
			Close up	Sweep energised
		Running	At dip	Sweep de-energised
		Recovering	At the dip	Sweep de-energised
			Hauled down	Gear dis-connected
Mechanical sweeping (Oropesa and team)	*By day* 3 black balls *By nights* 3 green lights	From beginning of streaming to end of recovering	One at mast-head, one at both yard-arms	Sweep operations in progress

Table 9-2. Signals when Sweeping

TYPE	SIGNAL	OCCASION	WHERE DISPLAYED	MEANING
Minehunter	*By day* 3 black balls *By night* 3 green lights	During the whole operation	One at masthead, one at both yardarms	Minehunting in progress (underwater vehicle possibly in operations)
	By day Flag A	When diving	Yardarm(s)	Divers in the water
Diving dinghy	*By day* Flag A or Flag B *By night* 1 white light	When approached by vessels	On board the dinghy	Divers in the water

Table 9-3. Signals by Minehunters and Diving Dinghies

ANNEX A

THE MCM OPERATION ORDER

1. INTRODUCTION

a. This section gives detailed instructions for preparing the MCM Operation Order (OPORD) and its annexes but although the examples of the principles explained here are for MCM operations they can also be applied to all mine warfare operations.

b. Information required for the MCM operation order, except for the task force organisations, is obtained from the operational planning data developed in Annex A of the OPORD. Task force organisation is dependent upon the determination of tasks, as discussed below in paragraph 5.

2. THE BASIC FORMAT OF THE OPORD IS AS GIVEN BELOW

Issuing headquarters
Message reference number

TYPE AND SERIAL NUMBER OF OPERATION ORDER

EXERCISE NICKNAME

Reference: Maps (with UTM guides or Mercator/GNOMIC projections), charts and relevant documents. Time zone used throughout the order.

TASK ORGANISATION

Under this heading, list only the major force commanders and their task designators. Detailed task organisations are set out in Annex A.

NOTE: In a small exercise, the entire task organisation may be included here.

1. SITUATION
Give a brief summary of the political and military situation pertaining to the exercise and state the type of exercise to be conducted, the exercise area and the time and duration of the exercise. In addition, the following sub-paragraphs will be included as necessary.

a. Exercise forces.

b. DISTAFF organisation.

c. NATO participants.

d. Partner participants.

e. Attachments and detachments of participating forces.

2. MISSION
Provide a clear statement of the task of the exercise forces, including the aim of the exercise. The main exercise objectives may be included.

3. EXECUTION
a. Concept of operations
This sub-paragraph is to provide a clear statement of the overall plan for the exercise and is to contain an outline summary of the principal courses of intended action. It will include the significant dates in the exercise.

b. Conduct of operations
In this sub-paragraph set out the specific tasks and employment of the forces in the execution of the concept of operations for the exercise.

c. Coordinating Instructions
This sub-paragraph is to include:
(1) Rules, regulations and policy which govern the play of the exercise.
(2) Directives and authorization for direct liaison to enable further planning.

4. SERVICE SUPPORT
This paragraph is to contain a statement of the administrative and logistic arrangements for the support of the exercise which are of primary interest to the units and commands being supported. This paragraph may include:

a. Intentions regarding production and publication of OPORDs.
b. Policy for liaison officers and observers.
c. Public information policy.
d. Arrangements for post exercise discussion.
e. Recording, evaluation and reporting requirements.
f. Supporting service facilities and personnel to be provided by national authorities of Host and/or Sending Nations.

5. COMMAND AND SIGNAL

a. Command.
This sub-paragraph will include:

(1) The OSE, his headquarters, location and movements and his second-in-command and alternate HQs.

(2) The OCE, his headquarters, location and movements and his second-in-command and alternate HQs.

(3) Chief of the controlling DISTAFF (DICONSTAFF), including headquarters, location, movements, and alternate HQs and location(s) of PIC and VOB.

(4) Participating force commanders/staffs/HQs, including information on movements, alternate HQs as appropriate.

(5) Operating authorities (Maritime Patrol Aircraft (MPA), Airborne Early Warning forces etc.).

(6) Instructions on the assumption of command and/or control by commanders.

(7) Arrangements for emergency termination or suspension.

b. Signal
This sub-paragraph will include:

(1) Communications (internally and/or externally).

(2) Recognition and identification of exercise and non-exercise participants (e.g. passwords).

SIGNATURE OF COMMANDER(S)

List of Annexes to EXOPORD (as required)
Acknowledgement instructions
Authentication (if required)
List of Annexes
Distribution List

3. ANNEXES OF THE OPORD

The paragraphs of the Standard format for an Operation Order contain essential instructions and information only. This paragraph describes the type of material that may be contained in the annexes to the MCM OPORD. A sample operation order is given in paragraph 4.

a. Annex A : Task Organisation
This annex should cover all participating MCM forces, their task organisation, commanders, headquarters and, if feasible, the name and rank of each Commanding Officer.

b. Annex B : Intelligence

c. Annex D : Operations
Appendices 1, 2 and 3 below amplify the information contained in para 3 of the OPORD.

(1) APPENDIX 1 : Concept of Operations

(2) APPENDIX 2 : Conduct of Operations. This appendix includes information required for proper and effective conduct of mine countermeasures.

(a) Routes, channels, areas, reference points, buoyage plan, Navaids, chart datum.

(b) MCM operations (MCM techniques, MCM Task Order Book, schedule of events, movement plan, manoeuvring instructions).

(c) Task Order and Mine Reference Numbers.

(d) Berth and anchorages plans.

(3) APPENDIX 3 : Coordinating instructions

(a) MCM forces.

(b) Protection of MCM forces.

(c) Traffic and convoy.

d. Annex H : Amphibious Operations
Only to be applied in case of MCM support.

e. Annex K : Electronic Warfare

f. Annex N : Logistics

g. **Annex O : Safety Rules**
This annex will contain special rules not contained in relevant publications to avoid interference and inform on local arrangements for divers' safety.

h. **Annex Q : Nicknames, Codexes and Exercise terms**
These may be used for brief reference to preplanned action or to disguise certain activities.

i. **Annex R: Records and Reports**
This annex will state, which reports are to be submitted and when. Details on position reporting may be included, as well as instructions for coding and encrypting of positions.

j. **Annex S : Communications**

k. **Annex T : Planning Timetable**
In case a detailed time schedule becomes necessary, this annex will be used instead of Appendix 2 to Annex D.

l. **Annex W : Environmental Support**

(1) APPENDIX 1 : Meteorological Information.

(2) APPENDIX 2 : MCM Environment.

(3) APPENDIX 3 : Swell Recorder Plan. (This appendix gives locations and operating procedures for the use of swell recorders during the operation).

m. **Annex Z : Instructions for Supporting Orders and Inserts**

(1) APPENDIX 1 : List of publications referred to in Opord.

(2) APPENDIX 2 : List of Operation Orders, Operations Plans and other documents relevant for the operation.

n. **Annex AA : Distribution**

4. EXAMPLE OF A MCM OPORD

Copy No. of copies
Commander Standing
Naval Force Channel
CTG 428.9
HMS WILTON
DTG 220800Z SEP 1991
Msg Ref.No.238/00/NC

OPERATION ORDER 1/81

References: COMNAVNORTHWEST PLAN X
BA Chart 2807

Time Zone : ZULU

Task Organisation :

CTG 428.09	CSNFC in HMS WILTON
CTU 428.09.01	CO WILTON
TU 428.09.01	HMS WILTON (MHC)
CTU 428.09.02	CO BREYDEL
TU 428.09.02	BNS BREYDEL (MHSO)
CTU 428.09.03	CO LINDAU
TU 428.09.03	FGS LINDAU (MHC)
CTU 428.09.04	CO NAALDWIJK
TU 428.09.04	HNLMS NAALDWIJK (MSC) HNLMS NAARDEN (MSC)
TU 428.09.05	To be designated (one MHC)
TU 428.09.06	To be designated (MCS)

a. Situation

On 20 SEP aerial minelay has observed East of L.V. NOORDHINDER in the Deep Draft Route from the Dover Straits to the North Sea.

(1) ENEMY FORCES

The following mines are estimated to be laid :

(a) Bottom mines : Acoustic Magnetic Ground mines

(b) Moored mines : Not expected

(2) FRIENDLY FORCES

Five ATAF will provide air cover during daylight.

(3) ATTACHMENTS AND DETACHMENTS

TU 428.09.05 (MHC) and 428.09.06 (MCS) after assignment of additional forces in accordance with COMNAVNORTHWEST PLAN X to be allocated to CTG 428.09.

b. Mission
TG 428.09 will carry out mine countermeasures operations in the Deep Draft Route from point A to point G. starting at 22 SEP 91 first light in order to ensure safe passage of shipping from 24 SEP 91 onwards.

c. Execution

(1) CONCEPT OF OPERATIONS
Execute exploratory minehunting operations from point A to point G (locate, classify and plot). Compare the results with available survey data. On completion, identify minelike objects and mark. Clearance minehunting and influence sweeping will be alternated in mined areas. MCM Risk Directive B is in force.

(2) COORDINATING INSTRUCTIONS

(a) Mines to be recovered will be designated by CTG 428.09 CTU 428.09.02 will recover and transport.

(b) MW 126 (MCM BUOY REPORT) will be sent INFO to all TUs.

(c) Hunters and sweepers will only work together in areas longer than 6 nm. Hunters will give way to sweepers unless operating divers or ROV.

d. Service Support
All units shall be prepared to sail at 220400Z and be fully provisioned. Fuel and limited maintenance will not be available afloat before 23 SEP when a logistic support vessel will arrive in the operations area (TU 428.09.06). Food and fresh water will be available in OSTEND or FLUSHING during stand-off periods. Further details are contained in Annex N.

e. Command and Signal

(1) CTG 428.09 in HMS WILTON is Tasking Authority.

(2) Communications iaw Annex S.

Acknowledgement instructions: Acknowledge signal is to be sent.

Signature
Commander Standing Naval Force Channel

List of Annexes: ....(as required)

ANNEX B

MCM OPERATIONS DIRECTION

1. PURPOSE

The MCM Operations Direction (MCMOPDIR) is used by the OPCON-authority to order general execution of MCM operations by subordinate tasking authorities.

2. NUMBERING OF MCMOPDIR

In order to facilitate identification, each MCMOPDIR will be allotted an individual number consisting of three digits. MCMOPDIR numbers are promulgated consecutively.

3. AMPLIFYING INSTRUCTIONS FOR THE USE OF MCMOPDIR

All MCMOPDIR must have a number, but the individual paragraphs are only to be filled in when applicable. This means, for example, that MCMOPDIR 307 consisting of all paragraphs from 'A' to 'Z' might be amended by MCMOPDIR 312 consisting of paragraphs 'E' and 'Z' only.

4. MCMOPDIR FORMAT

The format of a MCMOPDIR is given in ANNEX E (MW 124).

ANNEX C

MCM-TASK ORDER

1. INSTRUCTION FOR DRAFTING TASK ORDERS

a. General

The following instructions are valid for drafting and signalling of task orders in order to keep them short and concise. Task orders are to be drafted as MW 125 signals (see annex E).

b. The Tasking Authority

The Tasking Authority is the Commander/Staff responsible for the tactical function of ordering tasks to MCMVs in a command operating area.

c. Detailed Instructions for Tasking

(1) Action addressees are to be the task unit(s) or the ship detailed to execute the task; information addressees are to be other authorities concerned.

(2) NUMBERING OF TASKS:

(a) A MCM standard task order is numbered by a task order number, which is composed of 6 or 7 alpha-numerics:

(I) 3 or 4 numbers issued from the operation order giving the designator of the area. Zones should be designated with 4 digits number.This number will be assigned by the originator of the MCMOPDIR.

(II) Two letter (standard letter suffixes) issued from Table 1-1, giving the type of MCM operation (stage or combination of stages).

(III) 1 number giving the sequence number of the task of that type in that area.

(b) Example.
Task order number 1045CH01 means: First task - clearance hunting in area 1045.

(3) For the execution of a definite task order, time of commencing the task is the time at which the first ship of the unit enters the track at the beginning of this task. The time of completing this task is the time at which the last ship of the task unit leaves the track at the end of the task. The time to commence the task is given as a date-time group. When the time of commencement of the task is on completion of the preceding one, it is indicated by the number of that task. When the start time of the task is not signalled, it is at the discretion of the tasked units.

(4) Tasked units are authorized to deviate from the ordered MCM task if the existing situation should so require, but these changes are to be reported to their tasking authority forthwith.

d. Classification and Security Information

(1) Although no set rules can be given, as a guide the following types of information may have to be safeguarded:

(a) Geographical positions whether these designate important areas, e.g. route positions, limits of anchorages etc.

(b) Slate of MCM operations at a given time.

(c) MCM procedures being used.

(d) Techniques being carried out and their effectiveness.

(2) For information to be safeguarded, the use of operational brevity codes, tactical codes and disguised positions should be considered.

e. Mine Index
The Mine Index is used to make necessary information on mine types short. For details see Annex J.

f. Use of Check-Sums

(1) A check-sum is a single number derived from the sum of all numbers of the field to which the check-sum applies. When the total sum is more than a single number, only the last number of that sum is used (e.g. check-sum of 2468 = 0, check-sum of 246 = 2).

(2) Check-sums are to be used to avoid confusion caused by errors in transmission on all positions, courses, speeds, and times when sent by RATT. Check-sum digits may also be used for ranges, frequencies etc.

g. Designating Positions

(1) Latitude and longitude are normally expressed in degrees, minutes and seconds or degrees, minutes and decimals of minutes. Leading zeros are required to fill latitude to five and longitude to six digits. Entries are to be separated by a hyphen (-) and each entry shall include a check-sum (e.g. 663412N2 - 0041502E2). It is advised to state the geodetic datum.

(2) UNIVERSAL TRANSVERSE MERCATOR (UTM) GRID.
Full position expressed in UTM-grid coordinates is given in:

GRID ZONE DESIGNATOR	e.g. 31 U
100 KILOMETRE SQUARE IDENTIFIER	e.g. ET
EASTING 2-5 DIGITS	e.g. 36630
NORTHING 2-5 DIGITS	e.g. 56861

The grid zone designator, separately or together with the 100 kilometre square identifier, may be omitted in local operations where ambiguity is not likely to occur. (e.g. ET 3663056861).

(3) BEARING AND DISTANCE FROM A REFERENCE POINT.
A position expressed in bearing and distance from a reference point is given in True bearing in degrees as three digits, reference point (may be secure) as two letters, Distance in nautical miles (e.g. 170EE12.5).

(4) POSITION ON THE ROUTE
A position on the Route (or channel centre line) is expressed by an alpha-numeric group from Route description (e.g. 250A is the position of point Alfa of Route 250). Parts of the Route (or channel centre line) are expressed by the position on the Route, followed by the distance along the route (or channel centre line), in nautical miles, going in alphabetical directions. (e.g. 60A2.5 to 60B2 means the part of Route 60 that is 2.5 nautical miles past position 60A to a point 2 nautical miles past position 60B).

(5) POSITION IN THE VICINITY OF THE ROUTE
The position in the vicinity of the Route is expressed by an alpha-numeric group composed in the following way. Position on the Route (or channel centre line) see subparagraph (4) above. Indication + (PS) or - (MS) from the Route (or channel centre line) (seen in alphabetical direction, PS to the right, MS to the left). Lateral distance in tens of yards (e.g. 60A2.5PS10).

The method of reporting to be used depends on the requirement in the various formats or Operations Orders, but in general the following may be stated:

METHOD	WHEN
Latitude and Longitude	To indicate and report positions on Routes, and in channels
UTM Grid	
Position on a Route	To indicate positions in tasking
Positions in vicinity of a Route	
Bearing and distance	To report positions in an anchorage or when using reference positions

h. Track/Buoy Designation
Track/buoy designation is made in accordance with chapter 1 section 4.

i. Mine Reference Numbers (MRN)
In mine countermeasures to facilitate subsequent reference and to avoid confusion and duplication in reports, every mine swept, hunted, destroyed, washed ashore or otherwise accounted for, should be allocated a Mine Reference Number (MRN). This number should then appear in all references to that mine, e.g. MCM Reports. The actual allocation of numbers to individual mines should be done by the MCMV concerned for mines disposed of during MCM operations, and by the appropriate command for all other mines, e.g. mines broken adrift, washed ashore etc. The Mine Reference Number MRN will consist of:

(1) The last two or three letters ot the ship's international call sign (see notes 1 and 2), followed by

(2) A two-figure number allocated by the ship.

Notes

1. Three letters are used when two ships have the same last two letters.

2. Units having no international call sign will be assigned a two letter group by their OPCON Authority.

(3) EXAMPLE : MRN 'PE 07' .
This MRN designates the seventh mine hunted by 'CALLIOPE', whose call sign is FBPE.

ANNEX D

MCM REPORTS

1. GUIDELINES FOR COMPLETING REPORTS

a. Levels of Reporting. The arrangement of the MCM reporting system is aimed at allowing authorities controlling mine countermeasures to display and evaluate the effectiveness of MCM forces and operations. It also provides superior authorities with information from which they can assess future operations. Two main levels of reporting can be identified:

(1) TACTICAL LEVEL
Units being controlled by an OTC will keep him informed by MCM reports stating the progress of work detailed to them by the appropriate task orders. Reports to be sent are stated in the task order. They also report those observations and events which will affect their task.

(2) OPERATIONAL LEVEL
Tasking authorities have to keep their OPCON Authority informed about the progress of work and the status of the enemy mine threat. The frequency of these reports will be ordered in the appropriate MCM Operations Direction (MCMOPDIR).

b. Originator
This may be the OTC when more than one MCM unit is on the same task, or may be a single MCM unit, e.g. minehunter.

c. Action Addressee
This must always be the next highest authority. There should be only one action addressee to any report. The action addressee is responsible for passing the information to other addressees when necessary.

d. Information Addressees
Generally there should be no information addressees. However, there may be occasions when certain information may need to be passed for information directly, and superior authorities must state the occasions on which this must be done. Individual OTCs and MCM units must use great discretion in passing messages for information, eg there is no requirement to have other units in the same task as information addressees to MINEREP since the information would already have been passed on a tactical circuit within the task unit as an emergency or amplifying report.

e. Precedence
The precedence given indicates the time scale within which the recipient requires to be informed after the actual event has taken place. Thus, again, it is for guidance only and may be changed at the discretion of the originator, e.g. when passing reports by hand message, a precedence of routine would normally be quite sufficient.

f. Time When Reports are to be Sent
The times given are the usual ones to ensure an even flow of information between all command levels and to ensure that information reaches the destination when required. Local conditions, e.g. physical separation of command levels, may require different times. These are to be ordered as necessary.

g. Date-Time Group
The date-time group of a report can be used to report the date-time of the event.

h. Mine Status
Status codes for mines from Table E-1 (on page E-23) may be used to shorten signals/reports.

ANNEX E

MINEWARFARE SIGNALS

Contents

A. MW TABLE

1. SAFETY MEASURES

MW 2 **DECK.** All men are to remain on deck.

MW 3 **DEGAUSSING.** Use degaussing equipment.

MW 5 **WATCH.** Set mine watch.

2. MINES/MINEFIELDS

MW 6 **AIRCRAFT MINES.** Object _____ was dropped by aircraft in position indicated.
1. Identified as a parachute mine
2. Believed to be a mine

MW 7 **CUT.** I have cut a mine (type____ from Annex J) adrift (in position indicated.

MW 8 **DANGEROUS AREA.** Area is dangerous on account of mines (type_______ from Annex J) and is enclosed in a circle of _____ miles radius with centre in position indicated.

MW 9 **ENEMY MINEFIELD POSITION.** Enemy minefield is bounded by lines joining positions indicated.

MW 11 **MINE IS** _____ (in position indicated).
1. Drifting
2. Exploded
3. Just awash
4. Neutralized
5. Of type ______ Annex J
6. Sinking slowly

MW 12 **MINES** (type _____ from Annex J) have been ____ in position indicated (number of mines _______).
1. Found
2. Reported

3. CLEARED CHANNEL/AREA

MW 30 **AREA.** The area to be swept/hunted is ___ (or___).
1. An area of width ____ hundred yards, the centreline of which lies between positions indicated
2. Area/channel number letter_____
3. Extend area to be swept in direction _____ from position _____ (for _____ miles).

MW 32 **BUOY** _____
1. Position of mine
2. Safe channel
3. Swept/hunted channel

MW 34 **CHANNEL/AREA** is clear of mines (or ____), NEGAT preceding means "CHANNEL/AREA is not clear of mines".
1. Has been searched
2. Is swept/hunted.

MW 37 **SWEPT CHANNEL.** MCM vessels are approaching entrance (or ___) of swept channel.
1. End.

4. TRACK POLICY

MW 40 **PORT/STBD. . . . ADJUST SWEEP.** (Or _____) (PORT/STBD may be used to indicate sides.)
1. Leave sweep fully veered and unchanged
2. Recover sweep
3. Recover sweep and stream opposite side
4. Recover wire sweep and stream influence sweep
5. Shorten in as required
6. Stream and veer sweep
7. Veer sweep to full length or length indicated (meters)

MW 43 **RUN COMMENCED.** Entered track _____ (at _____)

MW 44 **RUN COMPLETED.** Effective (or ____) run has been completed in track _____(at ____).
1. Partially effective
2. Completely ineffective

MW 45 **RUN NUMBER.** Present run is last of this task (or_______).
1. Run just completed by this unit or unit indicated in track ______ is allocated run number.
2. Number of runs in track will be ____ .

MW 46 **LEAVING CHANNEL.** _______ channel.
1. Report when leaving
2. I have left

MW 47 **TRACK** _____
1. My next track is _____
2. My present track is _____
3. Report when entering track
4. Report when leaving track
5. Request next track assignment
6. Resweep this track
7. Take track _____
8. Upon leaving present track, clear area and repair defects
9. Upon leaving present track proceed as indicated in signal following
10. What is your present track
11. Your next track is _____

MW 48 **TRACK SEQUENCE/SEPARATION.** Tracks are to be swept in succession at 3.000 yard interval (or using _____) in following sequence _________ (track designators separated by TACK) by all ships of this unit (or ship indicated). Ships are to navigate independently.
1. Lateral separation _____ yards
2. Longitudinal separation ______ yards

5. DAN LAYING/DAN RUNNING

MW 50 **DANBUOY** (number _____ following DESIG) is/has _____ .
1. Adrift
2. Broken stave
3. Cut
4. Datum dan
5. Deep danbuoy
6. In my sweep
7. Lifted
8. Lying flat
9. Not watching
10. Out of position
11. Scope of _____ yards
12. Sunk
13. The first
14. The last
15. To be cut
16. To be lifted
17. To be passed _____ yards
18. To be pointed
19. To be recovered
20. To be repaired
21. Unit
22. Without _____ from page E-22

MW 51 **DANBUOY** (number _____ following DESIG) is to be laid with _____ (List A) (Positioned with reference ____ (List B)).

List A		List B
1. Blue light	9. Lamp	A. Danbuoy indicated
2. Bright	10. Medium	B. Decca chain indicated
3. Constant tension gear	11. Radar reflector	C. Geographical position
4. Dim	12. Red light	D. Geographical position
5. Double	13. Single	E. Route buoy indicated
6. Flag (to be indicated)	14. Transponder	
7. Flashing light	15. White light	
8. Green light		

MW 52 **DANBUOY.** Let go danbuoy (or _____).

1. Short scope buoy

MW 53 **DANBUOY POSITION INDICATION.**_____

1. Bearing of danbuoy (number_______ following DESIG) is degrees from this unit, unit indicated, or danbuoy (number__________ following DESIG). (Distance ______ yards).
2. Check position of danbuoy (number _______ following DESIG).
3. Danbuoy (number ____ following DESIG) is _____ yards from correct position.
4. Danbuoy (number _____ following DESIG) is within 25 yards of my bow.

MW 55 **DANLINE.** _____

1. Danbuoy (number _____ following DESIG) is ____ yards further from the centre of the channel than the mean danline.
2. Danbuoy (number _____ following DESIG) is ____ yards nearer to the centre of the channel than the mean danline.
3. Following danbuoy (number ____ following DESIG) are on the mean danline.
4. Leave line indicated down
5. Line is ____ yards from channel centre.
6. Straighten the line.
7. Straighten the line next track.

MW 56 **DAN RANGE.** Range on passing danbuoy number _____ following DESIG is _____ yards.

MW 57 **DAN RANGE.** Report is to be made by ship indicated of range to danbuoy (number ___ following DESIG) on passing.

MW 58 **DAN RUNNING.** Take up dan running duties ____
1. Keeping abreast of ship indicated.
2. Keeping astern of ship indicated and be prepared to lay danbuoys if mines are cut.
3. Passing ____ yards from the line of buoys off the edge of the channel.
4. Passing _____ yards from the line of buoys off the opposite edge of the channel.

MW 61 **LAY DANBUOYS.** Ship indicated lay _____.
1. Danbuoys ______
   (a) Number of dans.
   (b) Bearing from datum danbuoy.
   (c) Interval between dans _____ miles.
2. Datum dan (in Position _____).
3. Line of dans _____.
   (a) Number of dans.
   (b) Distance from centre of channel ______ hundred yards.
   (c) First dan abreast channel point _____.
   (d) Interval between dans ______ miles from dan _____ to dan _____.
   (e) Direction of line from dan ____ to dan _____.
   (f) Position of line relative to channel (N, S, E, W).

6. MINESWEEPING

MW 65 **ACOUSTIC GEAR OPERATION.** Operate (List A) gear in _____ gear in _____ (List B)mode with standard settings (or with settings _____ (list C).

List A	List B	List C
1.Audio frequency hammer 2.Cavitating 3.Combination acoustic 4.Explosive 5.Low frequency (displacer with long eccentric) 6.Low frequency (diplacer with short eccentric) 7.Oscillator 8.Pipe noise maker 9.Very low frequency 10. _____ from page E-22	A. Continuous B. Modulated C. Pulsed D. Warbled	31. Build up ____ seconds 32. Build up to _____ per cent of maximum output 33. Cycle time ___ seconds 34. Decay and low _____ seconds 35. High frequency_____, low frequency 36. High ___ seconds 37. Interval between individual charges _____ seconds, interval between initial charges of each complete set ___ seconds. 38. Modulated cycle build up ___ high ___ low _____ (seconds) 39. ON ___ seconds, OFF___ seconds.

Example: MW 65-1-B-38-6-4-20.... Operate audio frequency hammer gear in modulated mode with settings modulated cycle build up 6 sec, high 4 sec, low 20 sec.

MW 66 **ARMING.** Sweeps are to be armed with _____ (List A cutters as indicated (List B).

List A	List B
1. Anti-obstructor	A. As previously directed
2. Explosive	B. Heavy arming
3. Mark _____following DESIG	C. Light arming
4. Static	D. Medium arming
	E. To a total of _____

MW 67 **CALIBRATE.** Proceed to calibrate _____

1. Kite/depressor
2. Otters for deep sweeping
3. Otters for normal sweeping

MW 69 **CUT/SLIP.** Cut sweep (or_____).
1. Cut sweep and mark position with danbuoy
2. Slip my sweep
3. Slip your sweep

MW 70 **DIAPHRAGM.** Use diaphragm of _____ inches of diameter.

MW 71 **DEPRESSOR/KITE/OTTER.** Adjust to same depth as in previous track (or____).(PORT/STBD may be added to indicate side of sweep)
1. Adjust gear to give swept depth of ______ meters for speed ____through the water.
2. Adjust gear to give swept depth of _____ meters for normal sweeping speed.
3. Raise depressor/kite.

MW 72 **DEPRESSOR/KITE/OTTER.** (PORT/STBD may be added to indicate side of sweep.)
1. Your depressor/kite is surfacing.
2. Your otter is surfacing.
3. Spread of your sweep is ____ yards.

MW 73 **DUTY ASSIGNMENT.** Take duty as_____.
1. Centre ship (when there is more than one centre ship, call signs are to be used to indicate sequence from left to right)
2. Mine disposal ship
3. Mine recovery ship
4. Slip ship
5. Winch ship

MW 74 **ENERGIZE.** Energize(or ____) sweeps.
1. De-energize

Note *:*
Red and black flags to be used as directed in chapter 9.

MW 75 **EXPLOSIVE SWEEP.** Fire explosive sweep salvoes at intervals of____.
1. _____ minutes
2. _____ hundred yards.

MW 78 **FLOAT/DIVERTER** is to carry light.

MW 79 **MAGNETIC GEAR OPERATION.** Operate ____ (List A) gear, with ____ (List B) pulse sequence, and ____ (List C) wave form; ON ____ sec, OFF ____ sec, cycle time ____ sec, at ___ hundred amperes sweep current.

List A	List B	List C
1.Asymmetrical closed loop.	A. All forward	31. Continuous
2.Asymmetrical diverted electrode	B. All reverse	32. Sawtooth
3.Solenoid (towed)	C. Forward - Forward - Reverse - Reverse	33. Sine
4.Straight electrode	D. Forward - Reverse	34. Square
5.Symmetrical close loop	E. Standard pulsing sequence	35. Trapezoidal wave form
6.Symmetrical diverted electrode	F. Synchronized, opposite polarity on first pulse	
7.___ from page E-22	G. Synchronized, same polarity on first pulse	

Example : MW 79-1-C-34-4-6-40-15 ... Operate asymmetrical closed loop gear, with forward-forward-reverse-reverse pulse sequence, and square wave form; ON 4 sec, OFF 6 sec, cycle time 40 sec, at 1500 AMP sweep current.

MW 80 **MECHANICAL SWEEP ORDER.** Stream mechanical sweep in accordance with task order (or use ___). (PORT or STBD to be added if only one side is to be streamed or if the sweeps are veered to a different length). (Type of sweep to be indicated from page E-22).

1. ___ meters of float wire
2. ___ meters of kite wire
3. ___ meters of sweep wire
4. Float pendants and depressor tow wire lengths to sweep to a depth of ___ meters at a speed of __ through the water.

MW 82 **OBSTRUCTION.** Strain indicates obstruction being dragged in sweep (or ______).

1. Haul out formation and clear sweep.

MW 83 **OVERLAP.**______

1. Maintain overlap of ____ tens of yards.
2. Maintain true overlap of _____ tens of yards.
3. You are maintaining an overlap which is ____ tens of yards less than ordered overlap.
4. You are maintaining an overlap which is ____ tens of yards more than ordered overlap.

MW 84 **PASSING IN THE TRACK.** Ships are to de-energize sweeps when within _____ hundred yards of each other.

MW 85 **PULSING.** Carry out static pulsing at _______ minute intervals.

MW 88 **SIGHT SWEEPS.** Sight sweeps (and/or ____).
1. Slip
2. Close in on guide to turning distance and slip.
3. On completion of present track sight sweeps and slip independently.

MW 89 **SWEEP.** Sweep with ship indicated (or____).
1. Over position where sweep parted (or position indicated).
2. Round buoy number ___ (to radius of ____ yards).

MW 90 **SWEEP DEPTH.** Sweep running depth is to be set/adjusted to ___ meters for ____ (Sweep from page E-22)(at speed ____).

MW 91 **SWEEP PARAMETERS.** Characteristic actuation width for ___ sweep is _____ tens of yards and characteristic actuation probability is _____ percent.
1. Acoustic
2. Combination acoustic-magnetic
3. Magnetic

MW 92 **SWEPT PATH.** Swept path of formation is estimated to be _ hundred yards.

MW 93 **TURNED.** I am being turned by sweep wire.

7. MINEHUNTING

MW 100 **BOTTOM CONDITIONS** in this area for minehunting are _____.
1. Average
2. Good
3. Poor

MW 101 **GROUND MINE** (in position ____)(or bearing ____ range __ yards from this ship or ship indicated) will be countermined at ____.

MW 102 LINE OF MINES. Line of mines is _____ bearing _____ from this ship or ship indicated (or from position) ______ (number of mines in line is ____).

1. Detected
2. Revealed
3. Suspected

MW 103 MARK mines cut with floating dan.

MW 105 MINE CONTACT (in position indicated) is to be_____.

1. Allocated MRN following DESIG
2. Classified as possible mine (or____ from Annex J)
3. Destroyed
4. Identified as _____ from Annex J
5. Investigated by divers (or ROV following DESIG)
6. Left for subsequent recovery and/or investigation
7. Located
8. Marked by _____ from page E-22
9. Neutralized
10. Recovered
11. Removed from channel
12. Reported

MW 106 MINE DANGER. Mines in area are dangerous to divers. No diving is to take place. (Mine disposal weapons and markers are NOT to be dropped closer than _______ yards from minelike contacts).

MW 107 MINEHUNTER PROTECTION. Ships conduct continuous acoustic sweep with (from page E-22) while hunting.

MW 109 MINEHUNTING. Underway minehunting is not possible due to __.

1. Bottom conditions
2. Weather

MW 110 MINEHUNTING TASK ALLOCATION. Ship indicated is to search _____.

1. Between channel points_____ and _____ following DESIG (or position indicated).
2. For mine type ____ from Annex J (reported in position ____) or allocated MRN ____).
3. In area indicated.
4. Round buoy number ____ (or position _____) to radius of ____ yards.

MW 111 MINEHUNTING TASK SITUATION REPORT. State of task is ____.
1. ____ percent complete.
2. Channel is clear of mines from _____ to _____ (or position indicated).
3. Channel is mined from _____ to _____ (or position indicated).
4. Channel is mined (position of MRN is ____).

MW 114 MINEHUNTING TRACKS. Conduct mine hunting on track designator _____ following DESIG (or use _____ tracks to cover the channel). (Track spacing is _______ yards).

MW 115 MINE REFERENCE NUMBER (MRN) following DESIG is allocated to ______.
1. Last mine report
2. Last mine swept/hunted (by ships indicated)

MW 116 MINE SWEPT/HUNTED (or______) (bearing ______ range yards from this or unit indicated) (or in position ________) (bearing _______ from reference point ______ range _____ yards).
1. Sighted

MW 117 OBSTRUCTOR is/has been _____.
1. Bouquet
2. Chain mooring
3. Cut in Position ____
4. Explosive cutter
5. Grapnel
6. Static cutter

MW 120 RECOVER MCM equipment (or ____ from page E-22).

MW 121 SONAR MCM SEARCH PROCEDURE. Conduct sonar search by _____ channel or area coordinates _____ (or codename following DESIG).
1.
2.
3. Clearing
4. Exploratory

8. MCM REPORTS

MW 124 MCM OPERATIONS DIRECTIONS. MCMOPDIR number____.

A.
1. Time to commence task (stop time may be added).
2. MCM units or elements detailed for the operation. (Optional if these units/ elements are action addressees).
3. Covering force.
4. Units detailed for logistic support.

B.
1. Area, routes or parts of routes where MCMOPS are to be carried out.
2. Priorities (anchorage, deployment areas, routes, etc.)

C.
1. MCM directive in force
2. Type of MCM operation

D. Intelligence (estimate of the threat)

E. Shipping management (e.g., convoy schedule and lead through policy).

F.
1. Estimate of the situation
2. Intentions

G. Report to be sent and when. Additional information required.

H. Movements on completion

I. Effort required:
1. Exploratory operations: confidence level (CL) and maximum acceptable number of mines (t).
2. Clearance hunting/mechanical sweeping: percentage clearance

X. Miscellaneous

Y. References

Z. Acknowledge

MW 125 TASK ORDER. Task order number ____. Carry out elements of tasks ordered below:

A. Units (not necessary when addressed unit is to perform task)
1. Discretion of CTU
2. Call sign of unit(s) to carry out task
3. ____ number of units to be on task

B. Time to commence
1. Immediately
2. Upon completion of present task
3. Upon completion of off-task period
4. ___ (DTG)
5. Complete prior to passage of convoy
6. Upon completion of repairs
7. To be signalled
8. As soon as weather permits
9. DESIG_____

C. Area or channel
1. Route number______
2. Channel number_____
3. Anchorage name _____
4. Between points_____
5. Position within 3 miles of position _____
6. Within 3 miles junction on routes_____
7. Harbour name _____
8. DESIG _____

D. Type of MCM operations
1. _____ (use standard letter suffix from Annex I/ two digit stage number)
2. Digit code group from appropriate OPORD
3. Danlaying
4. Mine recovery
5. DESIG ____

E. Mine types that may be encountered
1. ____ from Annex J)
2. As indicated in OPORD
3. No intelligence available
4. DESIG ____

F. Convoy information _____ Lead through order
1. Convoy title, name(s) of the independent(s) or task organization number.
2. Arrival position ____.
3. ETA (Zulu time) ____.
4. _____ Lead ship (number of convoy ships ____).
5. Lead through channel.

6. Stop convoy or independent unit until required clearance is obtained (two figures indicate required percentage where different from standard).
7. Do not lead through but pass required formations for transit of channel.
8. A. Call sign convoy Commodore/OTC naval force ____ on board ____ (name/call sign of ship).
   B. Call sign convoy vice commodore/designated substitute of OTC ____ on board ____ (name/call sign of ship).
9. Ship data
   A. Name ____ type ____ IRCS ____ manoeuvering/ navigation limitations ____.
   B. Name ____ type ____ IRCS ____ manoeuvering/ navigation limitations ____.
   C. Etc.
10. Establish contact on ________ (name HF/UHF/VHF communications) at _____ (DTG).
11. DESIG ____.

G. Communication instructions for MCM forces ____ (List A) and for unit(s) to be guided________ (List B).

List A
1. As indicated in COMPLAN
2. Line ____
3. UHF ____
4. VHF ____
5. HF ____
6. DESIG____

List B
1. As indicated in COMPLAN
2. Line ____
3. UHF ____
4. VHF ____
5. HF ____
6. DESIG____

H. MCM reports
1. MINEREP ____ report each mine swept/hunted
2. MCMSITREP ____ daily by time indicated
3. Start/stop time ____
4. DESIG ____

I. Movements upon completion
1. Return to Port
2. Return to support ship
3. Anchor (in position ____)
4. Commence off-task period (at ____)
5. New task to follow
6. If mine is swept/hunted, commence clearance operations
7. Stop present task at ____
8. Commence task number _____ (or DTG)
9. DESIG

J. Effort requested
1. _____ runs per track
2. _____ runs on track

3.
4. ______ percentage coverage
5. ______ percentage clearance
6. ______ number of units on task continuously
7. ______ number of tracks
8. Track spacing ____ tens of yards
9. DESIG ______

K. Coordination orders
1. Coordinating authority
2. Keep clear of convoy
3. Hunters keep clear of sweepers
4. Sweepers keep clear of hunters
5. Sweepers keep clear of hunters having divers in the water
6. In accordance with chapter 9
7. DESIG

N. Danlaying /lay danbuoys
1. Number of danbuoys
2. Position ________ (or first dan abreast channel point _)
3. Offset ______ tens of yards ______ (A plus B minus)
4. Interval between dans ______ hundreds of yards
5. Direction between the dans and lettered
6. Lift danbuoy(s) in position (_____)
7. Are laid
8. From page E-22
9. Discretion of call sign ____

U. Mechanical
1. Single oropesa
2. Double oropesa
3. ______ meters depth setting
4. Not be armed
5. To be armed ____ (List A) with ____ cutters (List B)

List A	List B
1. Light	A. Explosive
2. Medium	B. Static
3. Heavy	C. Type

6. Length of sweep wire ____ meters

V. Acoustic
1. Low frequency sweep
2. Audio frequency sweep
3. ____ inch diaphragm
4. ____ inch crankshaft
5. Continuous running
6. Modulating - build up ____ max ____ min ____seconds
7. Alternating ships LF/AF
8. As indicated in OPORD.

W. Magnetic (______)

(a) WAVE FORM
1. Square
2. One-half sinusoidal
3. Sinusoidal
4. One and one-half sinusoidal
5. One-half triangular
6. Triangular
7. One and one-half triangular
8. Trapezoidal

(b) CHANGE GEAR
1. 4 seconds
2. 8 seconds
3. 12 seconds
4. 16 seconds
5. 20 seconds
6. 24 seconds
7. ZOT (Zero-off time)

(c) _____ seconds on ____ seconds off

(d) Pulsing sequence
F or R   F or F   F or R   F or R

(e) AMPERAGE
1. Maximum
2. ____ AMPS
3. Safe current against mine of _____nT

X. Miscellaneous information following DESIG

Y. References following DESIG

Z. Acknowledge (if required)

MW 126 BUOY REPORT. Ship indicated has laid/checked/discovered.
1. In accordance with task order number____ (or DTG)
2. Number of danbuoys
3. Position ____ (or first buoy abreast channel point
4. Offset _____ tens of yards ____ (A plus, B minus)
5. Interval between buoys _____ hundreds of yards
6. Direction between buoys and lettered
7. Distinguished by flag DESIG
8. From page E-22
9. Missing or malfunctioning or ____
(1) Not watching
(2) Dragged direction ____ distance ____ yards
(3) Unlighted
(4) Adrift
(5) From page E-22

MW 127 START/STOP TIME. Task order number ____ has ____ (List A) due to ____ (List B) at ____ .

List A	List B
1. Will start at (DTG)	A. See state
2. Has started (DTG)	B. Visibility
3. Has stopped (DTG)	C. Breakdown of ____
4. Has been suspended (DTG)	D. In accordance with task order number (____) or DTG
5. Has resumed (DTG)	E. Off task period
6. Will resume at (DTG)	F. Other mission (reference)
7. Will be completed at (DTG)	G. DESIG ____

MW 128 MINE DETECTION/EXPLOSION REPORT

1. Mine ___, MRN ____
   A. *Swept*
   B. *Hunted*
   C. *Visual observed*
   D. *Exploded*
2. DTG (of the event) ___
3. Mine type (from Annex J)
4. Position ____ (geographical)
5. Location relative bearing _____ and range _______ to ship/helo ____
6. Course and speed of ____ name/number of the ship/helo
7. LRN ____
8. Status
   A. *Located ____*
   B. *Married to sinker*
   C. *Identified by divers*
   D. *Identified by underwater vehicle*
   E. *Disposed of by*
      1. *Neutralization*
      2. *Render safe*
      3. *Countermine*
      4. *Recovery*
      5. *Removal*
   F. *Sinker removed*
   G. *Sinker in position ____*
   H. *Destroyed by sweep (page E-22)*
   J. *Destroyed by gunfire and exploded*
   K. *Destroyed by gunfire and sunk in position ____*
   L. *Destroyed and exploded with explosive charge by divers*

9. DESIG ___

MW 129 MCM OPDEF (MCM OPERATIONAL DEFECTS).

1. Call sign(s) of unit(s) concerned
2. Position___
3. ETA support ship/base___
4. Defective equipment ____
5. Repairs can be effected by ship's crew
6. Non-operational
7. Equipment _____ operating at reduced efficiency
8. Request divers on arrival
9. Request replacement on arrival of damaged/defective equipment ___ (following DESIG)
10. Request replacement on arrival of lost ____ (page E-22)
11. Request base assistance on arrival
12. Estimated time of back on task is ____
13. Rectified time of back on task is ____
14. Remarks following DESIG

MW 130 MCM SITREP. Task order number/sequence number ____.

1. Task order number ____ stage ____ search ____ method.
2 Number of runs ____ on track ____ (A plus, B minus) ____ tens of meters or exact area covered by divers relative to reference points.
3. MRN ____ type ____ (from Annex J) status ____ position ____ LRN ____.
4. If different from the one ordered, segment lies between points ____ and ____.
5. Estimate navigational error ______ meters, lateral separation of tracks ____ meters, aggregate actuation width ____ meters.
6. Minehunting bottoms conditions ____ (See para 0408), under-water visibility ________ meters (1 or 2/ horizontally/vertical) where 1 stands for human eye and 2 for ROV, aggregate actuation width ____ meters.
7. Percentage clearance achieved ____.
8. Percentage coverage achieved ____.
9. Remaining ____ percent fuel, ____ percent water, ___ number of mine disposal weapons.
10. Estimate completion of task at ____, next time on __ and off task ____.
11. Intentions/direction of search being pursued/further movements.
12. Remarks.

MW 131 RELIEF REPORT

1. Task order number ____
2. Number of runs ____ on track ____ (A plus, B minus) _____
3. Track spacing ____ tens of yards
4. Number of mines disposed of __ MRN _____, position ____
5. Number of mines identified but not disposed of ____, MRN ____ , position ____.
6. Minelike contact(s) identified as nonmine in positions(s)_____
7. Minelike contact(s) located as possible mine and not identified in position(s)____
8. Contact(s) classified as non mine in position(s) ____ and identified as ____
   A. Rock
   B. Drum
   C. Sinker
   D. Wreck
9. Bottom condition ____
10. Remarks following DESIG.

MW 132 TASK CYCLE to be used _____.

1. At your discretion (or _____)
2. ____ on, ____ off
3. All units continuously on task
4. ____ percentage on task

MW 133 ALL TASKS are _____ now (or at _____).
1. To cease
2. To be resumed

MW 134 STOP PRESENT TASK and proceed as indicated.

1. To off-task period, resume present task at (_____)or end of off-task period
2. To off-task period, commence task number ____ at end of off-task period.
3. To off-task period, instructions or new task to follow
4. Commence as soon as possible task order number____
5. To anchorage
6. To call sign ____
7. To port
8. As previously directed (or ordered by ____).
9. DESIG ____

MW 135 DIVING INCIDENT
1. Recompression required (yes/no)
2. PIM ____
3. ETA ____

B. MCM EQUIPMENT TABLE

1. Use the groups from this table to supplement any group from the preceding MW-table or to supplement the MCM reports.

2. If it is necessary further to identify equipment, specify by adding DESIG and the appropriate type number or maker's name.

1Y-9Y. Not be used.

10Y. Anchor
11Y. Buoy
12Y. Buoy, Dan
13Y. Buoy, datum
14Y. Buoy, master reference
15Y. Buoy, position marker
16Y. Buoy, short scope
17Y. Cable
18Y. Cable, reel
19Y. Cutter
20Y. Cutter, end
21Y. Cutter, explosive
22Y. Cutter, static
23Y. Diaphragm
24Y. Diverter
25Y. Electrode
26Y. Flag
27Y. Float
28Y. Kite/depressor
29Y. Lamp
30Y. Line
31Y. Marker
32Y. Mine disposal vehicle
33Y. Otter
34Y. Pellets
35Y. Radar reflector
36Y. Remote operated vehicle
37Y. Remote operated vehicle, cutter
38Y. Rope
39Y. Rubber mooring
40Y. Sinker
41Y. Sonar, hand held
42Y. Sonar, main avoidance
43Y. Sonar, main classification
44Y. Sonar, main detection
45Y. Sonar, near field
46Y. Sonar, parametric
47Y. Sonar, reflector/diablo
48Y. Sonar, towed sidescan
49Y. Staff, stave
50Y. Sweep
51Y. Sweep, acoustic
52Y. Sweep, acoustic AF
53Y. Sweep, acoustic combined
54Y. Sweep, acoustic explosive
55Y. Sweep, acoustic LF
56Y. Sweep, acoustic monitor
57Y. Sweep, acoustic oscillator
58Y. Sweep, helicopter acoustic
59Y. Sweep, helicopter magnetic
60Y. Sweep, helicopter mechanical
61Y. Sweep, hovercraft acoustic
62Y. Sweep, hovercraft magnetic
63Y. Sweep, hovercraft mechanical
64Y. Sweep, magnetic closed loop
65Y. Sweep, magnetic electrode
66Y. Sweep, magnetic open loop
67Y. Sweep, magnetic solenoid
68Y. Sweep, mechanical antenna
69Y. Sweep, mechanical chain
70Y. Sweep, mechanical net
71Y. Sweep, mechanical oropesa
72Y. Sweep, mechanical snagline
73Y. Sweep, mechanical team
74Y. Sweep, pressure
75Y. Sweep, protection combination (mechanical/influence)
76Y. Swell recorder
77Y. Weight
78Y. Wire

C. MINE STATUS TABLE

STATUS	DESCRIPTION
FLOAT	Status of a moored mine (or exercise mine) after being swept. Designator FLOAT followed by Direction (3 numerics) eg FLOAT 045.
SUNK	Status of a moored mine, sunk by a mine disposal vessel. Designator SUNK followed by DTG (Verified time) eg SUNK 061715Z0.
DISP	Status of a moored mine, which was disposed of (exploded) by a mine disposal vessel. Designator DISP followed by DTG (Verified time) eg DISP 061731Z8.
FOULED	Status of a moored mine, which fouled the sweep during mechanical sweeping. Designator FOULED.
EXPL	Status of an influence mine, which exploded during sweeping and hunting operations (not by disposal techniques). Designator EXPL followed by relative bearing RED/GN, 3 numerics (000-180) and distance in metres separated by a hyphen (4 numerics) eg EXPL RED 125-450.
CMINED	Status of a hunted mine, which was countermined. Designator CMINED followed by DTG eg CMINED 161726Z3.
NEUTR	Status of a hunted mine, which was neutralised. Designator NEUTR followed by DTG eg NEUTR 270813Z1.
RSAFE	Status of a hunted mine, which was rendered safe. Designator RSAFE followed by DTG eg RSAFE 121606Z6.
RECVD	Status of a hunted mine, which was recovered. Designator RECVD followed by DTG eg RECVD 211256Z7.
RMVD	Status of a swept/hunted mine, which was removed from the shipping area (initial pos). Designator RMVD followed by 3 numerics (true bearing) and distance 4 numerics, separated by a hyphen (indicating metres) eg RMVD 210-1500.
NDEALT	Status of the mine not dealt with during hunting operations. Reason has to be stated under Remarks.

Table E-1. Mine Status

ANNEX F

PRELIMINARY TECHNICAL REPORT

(PRETECHREP)

1. To be submitted immediately following the acquisition of significant enemy equipment.

Precedence: -O-

From: LOCATING UNIT (OR ORIGINATING AUTHORITY)

To: Operational Control Authority

INFO: SPECIALIST EVALUATION TEAM/TECHNICAL INTELLIGENCE TEAM.

PRETECHREP

A. Type of equipment and quantity.

B. Date-time of capture.

C. Location (map reference).

D. Capturing unit and circumstances of capture.

E. Enemy formation from which captured.

F. Brief description with distinguishing marks and, if possible, manufacturer.

G. Technical characteristics with an immediate value, including information of any photographs available.

H. Time and origin of message.

J. Present location of disposal of captured enemy equipment.

K. Any other relevant information.

COMPREHENSIVE TECHNICAL REPORT

(COMTECHREP)

2. To be submitted within 72 hours after sending a PRETECHREP.

Precedence: -P-

From: TECHNICAL INTELLIGENCE TEAM

To: Operational Control Authority

INFO: SPECIALIST EVALUATION TEAM

COMTECHREP

A. Date found, location (map reference).

B. Type of equipment and quantity.

C. Origin.

D. Description with distinguishing marks (additional details).

E. Condition of equipment.

F. Technical characteristics of immediate tactical value (additional details).

G. Recommended disposal.

H. Name plates photographed.

I. Photographs taken.

J. Other information.

K. Name of team chief.

L. Time and origin of message.

ANNEX G

LEADTHROUGH MESSAGES

1. LEADTHROUGH ORDER

a. Purpose

For passing information to MCM Tasking Authorities about ETA and composition of convoy/naval force which has to pass a certain channel.

b. Format

ORIGINATOR :	OCA Transiting Units
ADDRESSEES :	MCM Tasking Authority
INFO :	Convoy Commodore/OTC Naval Force
EXERCISE or OPERATION :	EXER/or OPER/
IDENTIFICATION :	followed by nickname
MESSAGE IDENTIFIER :	LEADTHROUGH ORDER

A. Convoy title, name(s) of the independent(s) or task organization number
B. Position in which traffic will arrive (latitude, longitude and geodetic datum)
C. ETA (ZULU time)
D. Action to be taken, indicated by
   LEAD Leadthrough channel
   STOP Stop traffic until MCM effort required is obtained or risk is acceptable
   INFORM Do not leadthrough but pass the required information in order to transit the channel.
E. 1. Call sign Convoy Commodore/OTC NAVAL FORCE ________ on board ________ name c/s ship)

   2. Call sign Convoy Vice Commodore/designated substitute of OTC ________ on board ________ (name/ c/s ship).
F. SHIP DATA
   1. Name ________ type ________ IRCS ________ Manoeuvring/Navigation Limitations
   2. Name ________ type ________ IRCS ________ Manoeuvring/Navigation Limitations
   3. Etc.
G. Establish contact on ________ (name HF/UHF/VHF Communications).

c. Example

FROM COMGERNORSEA
TO GE COMMSQD 6 IN FGS WERRA
INFO CONVOY COMMODORE WHVPLYM-08 IN FGS HANSA
EXER/BLUE HARRIER 93
LEADTHROUGH ORDER

A. WHVPLYM-08
B. 5355N8 06650E1 ED50
C. 120400Z7 JAN
D. LEAD
E. 1. BULL - HANSA - DAUK
   2. CALF - AMSTERDAM - PBEI
F. 1. HANSA - AGQ/ADM ESCORT - DAUK
   2. LIESELOTTE - TMR - DIIV - RADAR DEFECTIVE
   3. AVENGER - TME - GBAD
   4. JENS-LEVIN - TMO - OUAQ
   5. AMSTERDAM - TMP - PBEI
   6. FLYING SCOTSMAN - TMOT -GDWC
   7. OSTFRIESLAND - TMR - DTOZ - SAILING WITH 50 PER CENT DEAD FREIGHT
G. 1. C/S BULL - UHF 279.4 MHZ
   2. SINGLE CONVOY SHIP : VHF CHANNEL 11
   3. LEADTHROUGH TRANSIT INSTRUCTIONS TO BE PASSED BY HEAVING LINE TO SINGLE CONVOY UNITS

2. LEADTHROUGH INFORMATION

a. Purpose

For passing information to OTC transiting units/convoy commodore about MCM data, including valid navigational warnings.

b. Format

ORIGINATOR : OCA Transiting Units
ADDRESSEES : OTC Naval Force/Convoy Commodore
INFO : MCM Tasking Authority
EXERCISE or OPERATION : EXER/or OPER/
IDENTIFICATION : followed by nickname
MESSAGE IDENTIFIER: LEADTHROUGH INFORMATION

A. Position of Channel (latitude/longitude and geodetic datum).
B. NAVWARNS in force for the respective area
C. State of MCM Operations, Estimation of Progress until ETA Convoy/Naval force
D. Communications EMCON Policy
E. Special Remarks :
(i.e. relevant publications, rendezvous positions, emergency anchorages, other forces in the area, orders for special emergency cases).

c. Example

FROM COMGERNORSEA
TO CONVOY COMMODORE WHVPLYM-08 IN FGS HANSA
INFO GE COMMSQD 6 IN FGS VERRA
EXER/BLUE HARRIER 93
LEADTHROUGH INFORMATION

A. FROM 5354,5N2 00640,8E8 TO 5352,1N6 00620,4E2-ED50
B. NAVWARNS 1,2 AND 3
C. SWEEPING/HUNTING IN PROGRESS SINCE THREE DAYS. RISK ASSUMED TO BE LOW AT ARRIVAL OF CONVOY WHVPLYM-08
D. COMGERNORSEA LEADTHROUGH ORDER (DTG ...) REFERS.EMCON POLICY TO BE RESTRICTIVE: LEADTHROUGH TRANSIT INSTRUCTIONS WILL BE PASSED BY MCMVS AS MANUSCRIPT MESSAGES BY HEAVING LINE
E. 1. CONVOY SHIPS TO BE LEAD THROUGH. RENDEZVOUS POSITION: 5355N8 00650E1
2. NO OTHER FORCES IN THE AREA

3. LEADTHROUGH TRANSIT INSTRUCTIONS

a. Purpose

Instructions issued by an OTC of MCM forces with the aim to pass necessary information for execution of a leadthrough operation to a naval force, convoy or independent unit.

b. Format

ORIGINATOR:	OTC of MCM Units
ADDRESSEES:	OTC of Naval Units or Convoy Commodore
INFO:	
EXERCISE or OPERATION IDENTIFICATION :	EXER/or OPER/ followed by nickname
MESSAGE IDENTIFIER :	LEADTHROUGH TRANSIT INSTRUCTIONS

A. Passage not permitted :
1. Stop immediately (Yes/No)
2. Anchor in position ______ until (DTG)
3. Sail to (as indicated)
4. Use diversion indicated
5. Estimated end of MCM operations (DTG)

B. Passage permitted:
1. Leadthrough (Yes/No)
2. Leading vessel will be unit indicated for ships indicated (to be repeated if more than one leading vessel will be employed)

C. Channel details (use column for every linear part of the channel):
1. Position of centreline (latitude/longitude and geodetic datum)
2. Length in nautical miles
3. Route (dan) buoy position(s) relative to route positions
4. Channel width in yards
5. Course of channel in degrees, and direction of (dan) buoy line in degrees if it is different
6. Number of (dan) buoys and spacing in hundreds of yards.

D. Special Instructions:
1. Maximum speed in kts
2. Ship spacing in hundreds of yards
3. Tidal current, direction ______, force ______ (kts) at ______(DTG)
4. Other units in the channel
5. Estimated time of entering channel
6. Visual signs in operation.

E. Special Remarks:
1. Dan (buoy) characteristics
2. Navigational hazards
3. Miscellaneous.

c. Example

FROM	GE COMDIV 62
TO	CONVOY COMMODORE WHVPLYM-08 IN FGS HANSA
INFO	ALL SHIPS OF CONVOY WHVPLYM-08 (BY HAND)

EXER/BLUE HARRIER 93
LEADTHROUGH TRANSIT INSTRUCTIONS

B. 1. YES
2. MHC CUXHAVEN (M 1078) FOR HANSA/LIESELOTTE/AVENGER MHC MARBURG (M 1080) FOR JENS-LEVIN/AMSTERDAM MSCD DUEREN (M 1079) FOR FLYING SCOTSMAN/OSTFRIESLAND

C. 1. 5354,5N2 00640,8E8 TO 5352,1N6 00620,4E2-ED50
2. 12
3. 346 DEGREE (TRUE) - 900 YDS
4. 800
5. 266
6. 13-20

D. 1. 6
2. 5
3. 255T2 - 1,1 - 120500Z8
250T7 - 0,8 - 120600Z9
4. NONE
5. 120450Z2

E. 1. ARE COLOURED LIGHT RED, CARRYING RADAR REFLECTOR, WHITE FLASHING LIGHTS AND YELLOW FLAGS
2. NONE

ANNEX H

OPTICAL GUIDANCE (Flag G) SIGNALS

This annex provides special signals used by lead ships and shore stations in a leadthrough operation. The alphabetical flag indicator for the table may be left flying in a superior position when successive signals from the table are used. These signals may be at the discretion of the OTC, transmitted as their Morse symbols to expedite signalling.

SIGNAL	PURPOSE	MEANING
G2	Identification	Hoist your call sign.
G3	Identification	Your call sign is ____.
G4	Identification	My call sign is ____ .
G5	Identification	Switch on a searchlight towards the guiding unit.
G6	Identification	Make series of flashes by light.
G7	Identification	I cannot see you.
G8	Identification	I can see you/you are identified.
G15	Channel	I am approaching entrance to the channel.
G16	Channel	I am at the entrance to the channel.
G18	Channel	You (or ship indicated) are to enter the channel at _____.
G19	Channel	Report time of entering and leaving channel of : a.Your ship b.First ship of column c.Last ship of column d.First and last ship of the column

G20	Channel	You have entered the channel.
G21	Channel	I am approaching the end of the channel.
G22	Channel	You have left the channel.
G32	Guidance	Request guidance trough the channel.
G34	Guidance	I will lead you (or units indicated) through the channel.
G35	Guidance	I am ready for guidance/guiding.
G36	Guidance	What is your minimum speed?
G37	Guidance	My minimum speed is ____ knots.
G38	Guidance	Speed during leadthrough will be ___ knots.
G39	Guidance	Form single column. Distance between ships is _____ hundred yards.
G40	Guidance	Distance between led unit and leading unit is to be ____ hundred yards.
G44	Guidance	You are _____ (list A) _____ (list B) List A: N. North; S. South; X. On the centre line; E. East; W. West List B: Yards
G45	Guidance	You are _____ (list A) _____ (list B) relative to heading. List A: L.Left of centre line; R.Right of centre line; X.On the centre line List B: Yards
G51	Guidance	I have ceased to guide you.
G52	Guidance	This regard my movements.
G53	Guidance	You are clear of the minefield. You may proceed without guidance.
G62	Movement	Stop your ship, remain in the channel.

G63	Movement	Anchor immediately.
G64	Movement	Weigh anchor.
G70	Communication	Maintain watch on VHF channel ______. Do not transmit except in emergency or as indicated by me.

ANNEX I

MCM- STAGES

1. STANDARD LETTER SUFFIXES AND ASSOCIATED STAGES

a. The standard Letter Suffixes (SLS) are used in assembling the task order number (see annex C para 1). SLS indicate the state or combination of stages, which must be executed in that particular task, within the framework of an MCM operation. Table I-1 shows the suffixes available. If no MCM operation is specified, the SLS 'ZZ', or one of the spare suffixes must be stated in the operation order.

b. If other stages as given in the standard list are required, this must be mentioned in the MCM task order.

c. The list of mine countermeasures stages may be found on the next pages. An MCM stage indicates the use of a specific MCM technique to counter a particular type or types of mine.

2. STANDARD LETTER SUFFIXES TO TASK ORDER NUMBERS

	First Lett	SECOND LETTERS						
		SWEEPING				HUNTING	CLEARANCE DIVING TEAM	OTHERS
		Mechanical	Magnetic	Acoustic	Combined			
OPERATIONS		11 to 13 and 61 to 63	21 to 25 and 71 to 75	31 to 39 and 71 to 75	71 to 75 conjunction with 81 to 89	14 and 50 to 59		91 to 93
Precursor	P	M	G	A	C	H		Z
Exploratory	E	M	G	A	C	H	D	Z
Clearance	C	M	G	A	C	H	D	Z
Buoy laying	B							Z
Others	Z							Z

Table I-1. Standard Letter Suffixes to Task Order Numbers

3. PRECURSOR STAGES AGAINST MOORED MINES

STAGE No	EFFECTIVE AGAINST	BY	USING	REMARKS
11	Shallow moored mines (or antennae close to the surface)	Helicopter MSI. Specially fitted small craft	Wire sweep	Precursor sweep to protect larger sweepers following in the wake. Sweeping techniques must be especially modified if used against antennae mines to ensure that these mines are not detonated close to the sweepers.
12	Antennae mines	All sweepers	Modified wire sweeps	
13	Snagline mines	Helicopter MSI. Specially fitted small craft.	Snagline sweep	Precursor sweep to protect sweepers following
14	Moored mines	Hunters/TROIKA control vessels	MH Sonars/Mine detection sonars	Precursor hunting

Table I-2

4. PRECURSOR STAGES AGAINST MAGNETIC MINES

STAGE No	EFFECTIVE AGAINST	BY	USING	REMARKS
21	Sensitive magnetic mines	All sweepers fitted	Magnetic solenoid sweep	Precursor sweep
22	Sensitive magnetic mines	All sweepers fitted	Magnetic electrode (straight-tail) sweep	Precursor sweep
23	Sensitive magnetic mines	All sweepers fitted	Magnetic eletrode (open-loop) sweep	Precursor sweep
24	Sensitive magnetic mines	All sweepers fitted	Closed-loop magnetic sweep	Precursor sweep
25	Sensitive magnetic mines	TROIKA	magnetic solenoid sweep	Remote controlled self propelled sweep. May be used in conjunction with other stages (38/39).

Table I-3

5. PRECURSOR STAGES AGAINST ACOUSTIC MINES

STAGE No	EFFECTIVE AGAINST	BY	USING	REMARKS
31	Acoustic mines	Aircraft or surface ships	Depth-charges or bombs	Precursor sweeping of simple acoustic mines. Not normally carried out.
32	Acoustic mines	Helicopter - Any ship so fitted	Explosive sweep	Precursor sweeping of simple acoustic mines. May be carried out at the beginning of any sweeping operation, and continued if it produces results.
33	Acoustic mines	Helicopter Sweepers so fitted	PNM, Unifoxer GBT or similar types	Precursor sweep. May be used in conjunction with other stages.
34	Acoustic mines	All sweepers fitted	AF sweep (hammer) at long stay astern	Precursor sweep. May be used in conjunction with other stages.
35	Acoustic mines	All sweepers fitted	LF sweep at long stay astern	Precursor sweep. May be used in conjunction with other stages.
36	Acoustic mines	All sweepers fitted	Tuned oscillator sweep at long stay astern	Precursor sweep. May be used in conjunction with other stages.
37	Acoustic mines	All sweepers fitted	Unified LF?AF Sweep towed at long stay	Precursor sweep. May be used in conjunction with other stages.
38	Acoustic mines	TROIKA	AF sweep (hammer) installed in MSD	Remote controlled selfpropelled sweep. May be used in conjunction with other stages (25/39)
39	Acoustic mines	TROIKA	LF sweep towed by MSD	Remote controlled self-propelled sweep. May be used in conjunction with other stages (25/38).

Table I-4

6. MINEHUNTING STAGES

STAGE No	BY	USING	REMARKS
50	Minehunters/MSCD control vessels *	Acoustic M/H Systems	Classify and plot. MSCD: Moored mines only
51	Minehunters	Acoustic M/H Systems	Identity and plot.
52	Minehunters/MSCD control vessels *	Acoustic M/H Systems	Classify and mark. MSCD: Moored mines only.
53	Minehunters	Acoustic M/H Systems	Identify and mark
54	Minehunters	Acoustic M/H systems	Classify and neutralize.
55	Minehunters	Acoustic M/H Systems	Identify and neutralize.
56	Minehunters/MSCD Control vessels *	Acoustic M/H systems	Classifiy and countermine. MSCD: Moored mines only.
57	Minehunters	Acoustic M/H Systems	Identify and countermine.
59		Any other system	

Table I-5

* equipped with mine avoiding sonar.

7. MECHANICAL SWEEPING STAGES

STAGE No	EFFECTIVE AGAINST	BY	USING	REMARKS
61	Moored mines	All sweepers fitted	Wire sweep	Conventional wire sweep using fixed depth setting. May be used in conjunction with other stages.
62	Moored mines	All sweepers fitted	Wire sweep	Wire sweep with variable depth setting (team sweep).
63	Deep moored mines	All sweepers fitted	Wire team sweep	Wire sweep with variable depth setting (deep sweeping with team sweep).

Table I-6

8. MAGNETIC SWEEPING STAGES

STAGE No	EFFECTIVE AGAINST	BY	USING	REMARKS
71	Magnetic mines	All sweepers fitted	Magnetic solenoid sweep	May be used in conjunction with other stages.
72	Magnetic mines	All sweepers fitted	Magnetic electrolde (straight-tail) sweep	May be used in conjunction with other stages.
73	Magnetic mines	All sweepers fitted	Magnetic electrolde (open-loop) sweep	May be used in conjunction with other stages.
74	Magnetic mines	All sweepers fitted	Closed-loop magnetic sweep	May be used in conjunction with other stages.
75	Magnetic mines	TROIKA	Magnetic solenoid sweep	Remote controlled self propelled sweep. May be used in conjunction with other stages (88/89).

Table I-7

9. ACOUSTIC SWEEPING STAGES

STAGE No	EFFECTIVE AGAINST	BY	USING	REMARKS
81	Acoustic mines	All sweepers fitted	AF sweep abeam	The risk from coarse acoustic and sensitive magnetic mines must always be considered.
82	Acoustic mines	All sweepers fitted	LF sweep abeam	May be used in conjunction with other stages.
83	Acoustic mines	All sweepers fitted	PNM, Unifoxer, GBT, or similar type	May be used in conjunction with other stages.
84	Acoustic mines	All sweepers fitted	AF (hammer) sweep at long stay astern	May be used in conjunction with other stages.
85	Acoustic mines	All sweepers fitted	LF sweep at long say astern	May be used in conjunction with other stages
86	Acoustic mines	All sweepers fitted	Tuned oscillator at long stay astern	May be used in conjunction with other stages
87	Acoustic mines	All sweepers fitted	Unified LF/AF sweep towed at long stay	May be used in conjunction with other stages.
88	Acoustic mines	TROIKA	AF sweep in MSD	May be used in conjunction with other stages (75/88).
89	Acoustic mines	TROIKA	lf sweep towed by MSD	May be used in conjunction with other stages (75/88).

Table I-8

ANNEX J

MINE INDEX

1. The Mine Index is a code to indicate a certain mine type, for use in task orders and in the MCM reporting system. When the code from the Mine Index is used in other messages or circumstances, the code should be prefixed by 'MINE INDEX'.

2. The Mine Index is composed of 2 to 4 alpha-numerics giving an indication of the mine case and the firing system.

Example: 6 KFT means
6 - Ground mine with a charge of 500 kg or greater.
K - Magnetic (horizontal component) firing system.
F - Combined with an acoustic (low-frequency) firing system.
T - Overlap

3. **Mine Index List:**

MINE CASE
0 - No information on the mine body
1 - Moored mine
2 - Shallow moored mine
3 - Deep moored mine
4 - Ground mine
5 - Ground mine - explosive charge of less than 500 kg
6 - Ground mine - explosive charge of 500 kg or greater
7 - Contact classified as 'mine-like' (used in minehunting)
8 - Obstructors
9 - Moving mines

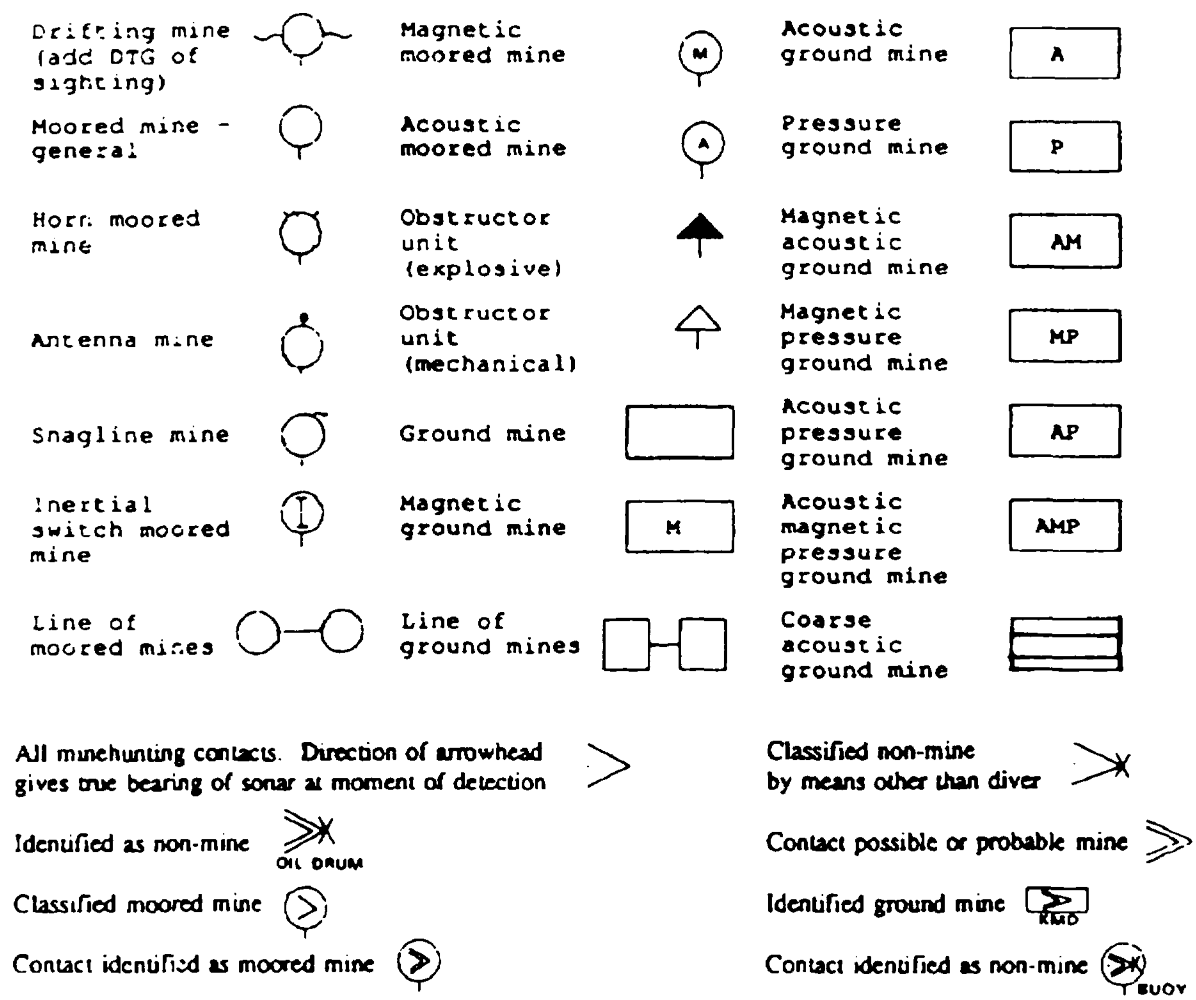
FIRING SYSTEM
A - Contact
B - Antenna
C - Influence
D - Acoustic
E - Acoustic audio frequency
F - Acoustic low frequency
G - Acoustic high frequency
H - Passive
I - Pressure
J - Magnetic
K - Magnetic H (Horizontal component)
L - Magnetic V (Vertical component)
M - Magnetic T (Total component)
N - Sensitive for normal target

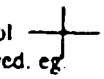
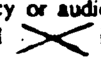
O -
P - Very sensitive (anti-sweeper)
Q - Coarse (anti-sweep)
R - Multi-look mines
S - Sequence
T - Combination (overlap)
U - Fitted with ship counter
V - Fitted with delayed arming or rising mechanism
W - Active
X - No information on firing mechanism
Y -
Z - Minehunting sonar decoy

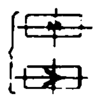
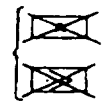
ANNEX K

MANUAL PLOTTING SYMBOLS USED IN MCM

The symbols below are for use in HQ's on charts and display plots and also on plotting table sheets in minesweepers, minehunters and when compiling clearance divers' plots.



Against acoustic mines, suffix (L) or (A) indicates low frequency or audio frequency. The symbol  superimposed on a mine symbol indicates 'neutralised' and symbol  indicates swept or destroyed, eg.

Mine neutralised  Mine destroyed 

SUFFIXES (Plot designator (or (MRN — Symbols may change (eg a contact classified as mine may subsequently be identified by diver as non-mine) but the serial number must remain the same.

NS. Not seen, either by the sensor on a subsequent run or by diver.

D S or V against a neutralised or destroyed mine indicates method used (D, diver; S, self-propelled charge; V, vectored charge).

Contact clusters are indicated by circles which are distinguished from moored mine symbols by having no mooring cable shown, and usually also by the circle being larger than the moored mine symbol. Contacts from other ships should be plotted in a different colour; similarly when symbols are used in a master plot, it may be convenient to have different colours for each ship.

ANNEX L

GLOSSARY OF MINE WARFARE TERMS

ACOUSTIC CIRCUIT An influence mine circuit which responds to the change of noise level caused by an approaching ship, submarine or sweep.

ACOUSTIC MINE A mine with an acoustic circuit which responds to the acoustic field of a ship or sweep.

ACOUSTIC MINEHUNTING The use of sonar to find mines which may be in the water volume, on the sea bed or buried.

ACTIVE MINE A mine actuated by the reflection from a target of a signal emitted by the mine.

ACTUATE To operate a mine firing mechanism by an influence or a series of influences in such a way that all the requirements of the mechanism for firing, or for registering a ship count, are met.

ACTUATION PROBABILITY AREA The area is a horizontal plane within which the sweeper sweep combination will intercept an armed mine or its appendages with the necessary condition to cause a buoyant mine's mooring to be cut, a contact mine to be fired or an influence mine to be actuated.

AGGREGATE ACTUATION WIDTH This is numerically equal to the area under the graph showing how mine actuation probability varies with distance from the sweep's centre of influence.

AGGREGATE DANGER WIDTH For a given mine this is the integral of $P_d(y)$ where y i the athwarthship distance from the track of the MCMV and Pd is the probability of an actuation within the MCMVs danger area.

AGGREGATION DETECTION WIDTH — This is numerically equal to the area under the graph of mine detection probability for detectable mines against distance from the track of the detection gear.

ANTENNA MINE — A contact mine fitted with antenna which, when touched by a ferrous object, set up galvanic action to fire the mine. The antenna generally takes the form of a special section in the mooring cable, and/or special cable suspended above the mine by a float.

ANTI-SUBMARINE MINEFIELD — A field laid specifically against submarines. It may be unsafe for all vehicles, or deep and safe for surface vehicles to cross.

ANTI-SWEEP DEVICE — Any device incorporated in the mooring of a mine or obstructor, or in the mine circuits to make the sweeping of the mine more difficult.

APPROACH ROUTE — A sea route which joins a port to the coastal or a transit route.

ARMED MINE — A mine from which all safety devices have been withdrawn and, after laying, all automatic safety features and/or arming delays have operated. Such a mine is ready to receive a target signal, influence or contact.

ARMED SWEEP — A sweep is said to be armed when it has been fitted with cutters or other devices to increase its ability to cut mine moorings.

ARMING DELAY DEVICE — A device fitted in a mine to prevent it being actuated for a preset time after laying.

ASSEMBLY CONFIGURATION OF MINES — This is a means of referring to the assembly configuration of mines, by various numbered configuration.

ATTENUATION — Decrease in density of a signal, beam, wave or influence as a result of absorption of energy and of scattering out of the path of a detector.

AUDIO FREQUENCY (AF) (See also ACOUSTIC CIRCUIT). Frequencies between 30 Hz and 1500 Hz.

ASYMMETRICAL MCM GEAR Any MCM Gear whose centre of actuation, influence, detection or cutting is displaced from the centre line of the MCMV.

AVERAGE ACTUATION AREA The integral, over a plan perpendicular of the centre line of the target ship, of the probability P(y, z) of actuation of a mine under specified conditions.

AVERAGE ACTUATION WIDTH The integral, over athwartship distance between the mine and the keel of the target ship, of the probability P(y) of actuation of a mine at a given depth and under specified conditions.

BOTTOM MINE (see GROUND MINE and MINE).

BOTTOM SWEEP A sweep, either wire or chain used either to sweep moored mines from a channel by dragging them to a nominated area.

BOUQUET MINE A mine in which a number of buoyant mine cases are attached to the same sinker so that when the mooring of one mine case is cut, another mine rises from the sinker to its set depth.

CHANNEL The whole or part of a route specified by a width in which MCM operations have been or are being conducted.

CHARACTERISTIC ACTUATION PROBABILITY Approximately the average probability of a mine of a given type being actuated by one run of the sweep within the characteristic actuation width.

CHARACTERISTIC ACTUATION WIDTH Approximately the width of path over which mines can be actuated by a single run of the sweep gear.

CHARACTERISTIC DETECTION PROBABILITY Approximately the ratio of the number of mines detected on a single run to the number of mines which could have been detected within the characteristic detection width.

CHARACTERISTIC DETECTION WIDTH	Approximately the width of path over which mines can be detected on a single run of the detecting gear.
CHEMICAL HORN	A horn comprising an electric battery, the electrolyte for which is in a glass tube protected by a thin sheet. Also called a Hertz Horn.
CLASSIFICATION	The evaluation of a Detection.
CLASSIFICATION RANGE	The range at which a contact is classified. (This may be applied by the prefix Actual Expected or Maximum).
CLEARANCE DIVER	Diver who is trained for air scuba and mixed gas scuba diving, qualified to carry out tasks in mine/ordnance search, investigation, recovery and removal underwater and ashore.
CLEARANCE DIVING TEAM	Group of clearance divers established to conduct clearance diving tasks. It may be embarked in a MCM vessel or operate from ashore from a mobile support facility. The group includes a leader and medical personnel.
CLEARANCE MCM OPERATIONS	Operations whose objective is to clear all mines from an area, channel or route.
CLEARANCE RATE	The area which would be cleared per unit time with a stated minimum percentage clearance, using specific MCM procedures.
COARSE MINE	A relatively insensitive influence mine.
COASTAL ROUTE	A sea route, normally following the coastline, which joins adjacent approach routes.
COMBINATION CIRCUIT	A mine firing circuit which requires actuation by two or more influences, either simultaneously or at a pre-ordained interval, before the circuit can function. Also called 'Combined Circuit'.

COMBINATION INFLUENCE MINE A mine with a combination circuit designed to actuate only when two or more different influences or different types of the same influence are received simultaneously or in/at a pre-ordained order or interval. Also known as a 'Combined Influence Mine'.

CONTACT **a.** Any indication on the display equipment of the presence of an underwater object.
b. The object or phenomenon causing such indication.

CONTACT LEVEL The minimum suction which will first operate the pressure unit contact.

CONTACT MINE A mine which is designed to fire by physical contact between the target and the mine case or its appendages.

CONTROLLED MINE A mine which after laying can be controlled by the user to the extent of making the mine armed or safe or to fire the mine.

COUNTERMINE The process of exploding the main charge in a mine by the shock of a nearby explosion of another mine or independent explosive charge. The explosion may be caused either by sympathetic detonation of the main charge, or through the explosive train of firing mechanism of the mine.

CREEPING MINE A buoyant mine held below the surface by a weight usually in the form of a chain which is free to creep along the seabed under the influence of the stream or current.

CUTTER In naval mine warfare a device fitted to a sweep wire to cut or part the mooring of mines or obstructors ; it may also be fitted in, or to, the mooring of a mine or obstructor to part a sweep wire.

DAMAGE AREA

a. The integral of the probability P(y,z) of actuation of a mine under specified conditions, integrated only over those values of y and z for which the explosion of the mine is likely to do at least a specified amount of damage.
b. The plan area around an MCMV inside which a mine explosion is likely to interrupt operations.

DAMAGE RADIUS

The average distance from a ship within which a mine containing a given mass and type of explosive must detonate if it is to inflict a specified amount of damage.

DAMAGE THREAT

The probability that a target vehicle passing once through a minefield will explode one or more mines and sustain at least a specified amount of damage.

DAMAGE WIDTH

The integral of the probability P(y) of actuation of a mine under specified conditions, integrated only over those values of athwartship distance y for which the explosion of the mine is likely to damage over different required levels.

DAN RUNNER

A ship running a line of buoys.

DANGER AREA

That part of the mine's firing area which is inside the damage area of an MCMV with respect to the same given mine.

DANGEROUS AREA

An area dangerous to shipping. This may be caused by mines, wrecks or shoals. See Mined Area.

DATUM MCM BUOY

A MCM buoy intended as a geographical reference or check, which needs to be more visible and more securely moored than a normal MCM buoy.

DEEP MINEFIELD

An anti-submarine minefield which is safe for surface vessels to cross.

DEFENSIVE MCM

Countermeasures intended to reduce the effect of enemy minelaying.

DEFENSIVE MINEFIELD	A minefield laid in international waters or international straits with the declared intention of controlling shipping in defence of sea communications.
DEGAUSSING	The process whereby a ship's magnetic field is reduced by the use of electromagnetic coils, permanent magnets or other means.
DELAY TIME	The time between the application of the minimum pulse field and the registration of the look under consideration.
DESTRUCTION RADIUS	The maximum distance from an exploding charge of stated size and type at which a mine will be destroyed by sympathetic detonation of the main charge, with a stated probability of destruction, regardless of orientation.
DETECTING CIRCUIT	That part of a mine circuit which responds to a change in the physical conditions at the mine.
DETECTION	The discovery by any means of the presence of a person, object or phenomenon of potential military significance.
DIP	The amount by which a moored mine is carried beneath its set depth by a current or tidal stream acting on the mine casing and mooring.
DIRECTIVE	Ordered as A, B or C. The directive ordered indicates the risk of MCM vessels acceptable whilst carrying out an MCM operation.
DISARMED MINE	A mine which has been rendered permanently inoperative by breaking a link in the firing circuit.

DISCRIMINATING CIRCUIT — That part of the operating circuit of a sea mine which distinguished between the response of the detecting circuit to the passage of a vehicle and the response to some other disturbances, (e.g. influence sweep, countermining, etc).

DIVERSION — A temporary route which bypasses a section or the whole of a transit coastal or approach route or link.

DORMANT — The state of a mine during which a time delay feature prevents it from being actuated.

DRIFTING MINE — A buoyant or neutrally buoyant mine, free to move under the influence of wind, waves, current or tide.

DRILL MINE — An inert filled mine, or minelike body, used in loading, laying or discharge practice and trails.

DRONE — A sea vehicle normally unmanned, which is remotely or automatically controlled.

DUMMY MINEFIELD — A minefield containing no live mines and presenting only a psychological threat.

ELECTRODE SWEEP — A magnetic cable sweep in which the salt water and seabed form part of the electric circuit.

EXERCISE FILLED MINE — A mine containing an inert filling and an indicating device.

EXERCISE MINE — A mine suitable for use in mine warfare exercises fitted with visible or audible indicating devices to show where and when it would normally fire. A device to assist in mine recovery may also be fitted.

EXPLODE — Covers all cases of a mine being fired or detonated by causes known or unknown (for minesweeping reports to use of this term should be confined to mines exploded by gunfire).

EXPLORATORY MCM OPERATIONS The MCM operation in which a sample of the route or area is subjected to MCM procedures to determine the presence or absence of mines.

EXPLOSIVE FILLED MINE A mine containing an explosive charge but not necessarily the firing train needed to detonate it.

FIRE To detonate the mine's main explosive charge by means of the mine's firing system.

FIRING AREA In a sweeper-sweep combination it is the horizontal area at the depth of a particular mine will detonate. The firing area has exactly the same dimensions as the actuation probability area but will lie astern of it unless the mine detonates immediately when actuated.

FIRING CIRCUIT That part of a mine circuit which either fires the detonator or operates a ship counter.

FITTED MINE A mine containing an explosive charge, a primer, detonator and firing system.

FLOATING MINE A mine visible on the surface. Whenever possible it should be more exactly defined by the term Drifting Mine, Free Mine or Watching Mine.

FLOODER A device fitted to a buoyant mine which, on operation after a preset time, floods the mine case and causes it to sink to the bottom.

FRACTION OF AREA COVERED Used in MCM operation to denote progress of the task ; it is that fraction of the assigned task area which has to date been covered by the tasked MCMVs.

FREE MINE A moored mine whose mooring has parted or been cut.

GAP	An area within a minefield or obstacle belt, free of live mines or obstacles whose width or direction will allow a friendly force to pass through in tactical formation.
GRADIENT CIRCUIT	A circuit which is actuated when the rate of change, with time, of the magnitude of the influence is within predetermined limits.
GRAPNEL	A device fitted to a mine mooring designed to grapple the sweep wire when the mooring is cut.
GROUND MINE	A ground mine rests on, or can become buried in, the seabed and is held there by its own mass. Its firing mechanism is of the influence type.
HIGH FREQUENCY (HF)	See Acoustic Circuit. Frequencies above 15,000 Hz.
HOLD-ON TIME	The time during which the threshold requirements of the mine must be satisfied.
HOLIDAY	A gap in MCM coverage left unintentionally during MCM operations due to errors in navigation, station keeping, buoy laying, breakdowns or other causes.
HORIZONTAL COMPONENT	That component of the total magnetic field in the horizontal plane.
HORN	A projection from the mine shell of some moored contact mines which, when broken, bent or moved by contact, causes the mine to fire.
IDENTIFICATION	The determination of the exact nature of an object detected and classified.
INDEPENDENT MINE	A mine which is not controlled after laying. It may be contact or influence; ground or moored.
INDUCTION CIRCUIT	A circuit actuated by the rate of change of a magnetic field due to the movement of a ship or the changing current in the sweep.

INERT FILLING	A prepared non-explosive mine filling of the same mass and density as an explosive filling.
INFLUENCE FIELD	The distribution in space of the influence of a surface vessel, submarine or minesweeping equipment.
INFLUENCE MINE	A mine actuated by the effect of a target on some physical condition in the vicinity of the mine or on radiations emanating from the mine.
INFLUENCE RELEASE SINKER	A sinker which holds a moored or rising mine at the seabed and release it when actuated by a suitable target influence.
INFLUENCE SWEEP	A sweep designed to produce an influence similar to that produced by a target and thus actuate mine.
INITIAL PATH SWEEPING	The first path swept through a mined area whose objective is to counter mines dangerous to following sweepers. Initial path sweeping is a form of precursor sweeping used for a particular purpose.
INTEGRATING	A circuit whose actuation is dependent on the time integral of a function of the influence.
INTENSITY MINE CIRCUIT	A circuit whose actuation is dependent on the field strength reaching a level differing by some preset minimum from that experienced by the mine when no ships are in the vicinity.
INTERMITTENT ARMING DEVICE	A device included in a mine so that it will be armed only at set times.
JETTISONED MINE	A mine which is laid as quickly as possible to empty the minelayer of its mines without regard to their condition or their position relative to each other.
KITE	A device which when towed submerges and planes at a predetermined depth without side-ways displacement.

LATERAL SEPARATION	The distance between the tracks of adjacent ships in a formation.
LAY REFERENCE NUMBER (LRN)	A number allocated to an individual mine by the minefield planning authority to provide a simple means of referring to it.
LEADTHROUGH OPERATIONS	Leadthrough operations are intended to assist traffic in the transit of parts of a mined area which have previously been subject to MCM effort.
LIVE MINE	A mine with an explosive filling and a means of firing the explosive charge.
LIVE PERIOD	The maximum time after the first look to satisfy all the subsequent looks and mine logic to cause an actuation.
LOCATE	To establish the precise position, of an underwater object relative to a ship, or to a specific navigational reference position.
LOOK	A period during which a mine circuit is receptive of an influence.
LOOP SWEEP	A magnetic cable sweep in which the current carrying conductors are insulated from the water throughout. The working portion of the sweep is spread by diverters to form a loop in the water.
LOW FREQUENCY (LF) (SUB-SONIC)	See Acoustic Circuit.Frequencies below 30 Hz.
MAGNETIC MINE	A mine with a magnetic influence circuit which responds to the magnetic field of a ship, submarine or sweep.
MAGNETIC MINEHUNTING	The process of using magnetic detectors to determine the presence of mines or minelike objects which may be either on, or protruding from, the seabed, or buried.
MARKING ERROR	The bearing and distance of a marker from a target.

MARRIED FAILURE A moored mine laying on the seabed connected to its sinker from which it has failed to release owing to defective mechanism.

MAXIMUM OUTPUT CONDITIONS Sweeping is carried out under maximum output conditions when sweeps are used at the full output of the generating source.

MAXIMUM TOWING SPEED The speed through the water which may not be exceeded without causing damage to the MCM gear or the towing vehicle.

MECHANICAL SWEEP Any sweep used with the object of physically contacting the mine or its appendages.

MINE A mine is an explosive device laid in the water with the intention of damaging or sinking or of deterring shipping from entering an area. The term does not include devices attached to the bottoms of ships or to harbour installations by personnel operating underwater.

MINEABLE WATERS Waters where mines of any given type may be effective against any given target.

MINE COUNTERMEASURES (MCM) Includes all measures for countering the mine by reducing or preventing danger or damage to ships and personnel.

MINE COUNTERMEASURES BUOY RUNNER A vehicle running along a line of MCM Buoys whether the vehicle is in fact conducting MCM operations or only being used for reference by other MCMVs.

MINE COUNTERMEASURES STAGES A MCM stage is the use of a specific MCM technique to counter a particular type of mine.

MINE COUNTERMEASURES TASK A MCM task is stage or combination of stages related to a specific channel or area of execution, time of execution and MCM forces for the execution.

MINE COUNTERMEASURES TECHNIQUE	The use of a specific MCMV and its equipment in a particular way.
MINE COUNTERMEASURES VEHICLE TRACK	The prescribed line over the ground to be made good by the MCMV to ensure the MCM gear follows the track. See Track.
MINE DENSITY	The number of mines per square nautical mile.
MINED AREA	An area declared dangerous owing to the presence or suspected presence of mines.
MINE DISPOSAL	The operation by suitably qualified personnel designed to render safe, neutralise, recover remove or destroy mines.
MINEFIELD	A number of mines laid, or declared to be laid, in a maritime area for any purpose.
MINEFIELD THREAT	The probability of a vessel exploding at least one mine on each pass through the minefield.
MINEHUNTING	The employment of ships, airborne equipment and/or divers to locate and dispose of individual mines. To found, to plot and to destroy.
MINELIKE CONTACTS (MILCO)	A minelike echo selected during the classification phase is referred to as a minelike contact.
MINELIKE ECHOES (MILEC)	These are echoes, which are, during the detection phase, selected within the clutter by sonar operator or automatic processing as being **Minelike** by criteria depending on the type of sonar being used and also on the experience such operators have in the use of their sonar.
MINE SPOTTING	The process of visually observing a mine or minefield.

MINESWEEPING	The technique of countering mines by minesweepers using mechanical or explosive gear, which physically removes or destroys the mine, or by producing, in the area, the influence field necessary to actuate it.
MINE WARFARE	The strategic and tactical use of mines and their countermeasures.
MINE WARFARE CHART	A special naval chart, at a scale of 1:50,000 or larger (preferably 1:25,000 or larger) designed for planning and executing mine warfare operations, either based on an existing standard nautical chart, or produced to special specifications.
MINE WARFARE GROUP	A task organisation of mine warfare vehicles for the conduct of minelaying and/or mine countermeasures in support of other types of maritime or combined operations.
MINE WATCHING	The mine countermeasures procedures to detect, record and, if possible, track potential minelayers and to detect and find the position of and/or identify mines during the actual minelay.
MINE WARFARE WEAPONS	The collective term for all weapons, gear and equipment used in mine warfare.
MINIMUM TOWING SPEED	The slowest speed through the water at which it is possible to proceed with MCM gear streamed and still counter the mine.
MIXED BAG	A collection of mines of various types, firing systems, sensitivities, arming delays and ship counter settings.
MODULATION	Variation of the amplitude of the sound output of an acoustic sweep.
MOORED MINE	A contact or influence fired mine of positive buoyancy held below the surface by a mooring attached to a sinker on the bottom.

NAVIGATIONAL ERROR	The navigational error is the lateral distance between the actual position of the vehicle and its intended track over the ground at any given moment.
NET SWEEP	Net sweeps are designed to collect mines and either detonate them by contact or dispose of them by dumping.
NEUTRALISATION	In MCM a mine is said to be neutralised when it has been rendered, by external means, permanently incapable of firing on passage of a vehicle or sweep, although it may remain dangerous to handle. The mine case may remain virtually intact.
NEUTRALISATION RADIUS	The greatest horizontal distance from an exploding charge of specified size at which a mine will be neutralised.
NON MINELIKE BOTTOM OBJECT (NOMBO)	Non mine minelike bottom objects are identified as non mine. They emanate from rock, reef, man made debris and may give minelike responses on minehunting sonars.
NUISANCE MINEFIELD	A minefield which is planned to force the enemy into taking countermeasures which adversely affect his war effort.
OBSTRUCTOR	A device laid with the sole object of obstructing or damaging mechanical minesweeping equipment.
OFFENSIVE MCM	Measures intended to prevent the enemy from successfully laying mines.
OFFENSIVE MINEFIELD	A minefield laid in enemy territorial waters or waters under enemy control.
ONE-LOOK CIRCUIT	A mine circuit which requires actuation by a given influence once only.
OPEN LOOP SWEEP	A loop sweep in which the after catenary (transverse portion of the cable) is omitted, each side leg of the 'loop' terminating in an electrode.

OPERATIONAL MINEHUNTING CLUTTER (OPS MH CLUTTER)
During the detection phase all echoes detected by a minhunter sonar-system which are repeatedly above the noise or the average reverberation background are referred to as Operational Minehunting Clutter.

OPERATIONAL SPEED
The highest speed at which ships will be required to proceed during a particular operation or during a stated period.

OPTICAL MINEHUNTING
The use of an optical system (eg television or towed diver) to detect and classify mines or minelike objects on or protruding from the seabed.

OPTIMUM MCM SPEED
The speed over the ground for a given set of conditions which provides the greatest sweeping/ hunting rate.

OROPESA SWEEP
A form of sweep in which a length of sweep wire is towed by a single ship, lateral displacement being caused by an Otter and depth being controlled at the ship end by a Kite and at the Otter end by a float and float wire.

OSCILLATING MINE
A moving mine which maintains its depth by means of a hydrostatic depth control mechanism, which causes it to oscillate about a set depth.

OTTER
In MCM, a device which, when towed, displaces itself sideways to a predetermined distance.

OVERLAP
The width of that part of the swept path of a ship or formation which also swept by an adjacent sweeper or formation or is re-swept on the next adjacent track.

PARAVANE
A towed body with planes and a cutter with a means of depth keeping, which displaces itself sideways and can be used as a ship protection measure against certain moored mines.

PASS
See Run.

PASSIVE MINE	A mine whose anti-countermining device has been operated preventing the firing mechanism from being actuated. The mine will usually remain passive for a comparatively short time. This term can also be used to describe all mines which do not emit a signal to detect a vessel, in contrast to 'Active mines' which detect a vessel by detecting the reflection by the vessel of a signal emitted by the mine.
PASSIVE MCM	Measures intended to localise the threat, locate the minefield and reduce the risk to shipping.
PERCENTAGE CLEARANCE	The estimated percentage of mines of specified characteristics which have been cleared from an area or channel.
POISED MINE	A mine in which the ship counter setting has been run down to ONE and which is ready to fire at the next actuation.
PRACTICE MINE	An inert filled mine but complete with assembly, suitable for instruction and for practice in preparation.
PRECURSOR MCM OPERATIONS	Operations in an area or channel using relatively safe methods and techniques in order to reduce the risk to MCMVs.
PROTECTIVE MINEFIELD	Minefield laid in waters under own or allied control to protect ports, harbours, anchorages, coasts and coastal routes.
PULSE CYCLE	**a. Standard Pulse Cycle (SPC)**. This is a nationally established pulse programme that is ordered for the respective sweep gear if no information on the actuation levels of mines being countered is available.

b. **Recommended Pulse Cycle (RPC)**. This is one of several alternative pulse programmes which are ordered if minesweeping operations are not achieving a satisfactory result using the Standard Pulse Cycle or if information on actuation levels has been obtained.

PULSE CYCLE PERIOD — The time interval between the beginning of one pulse and the beginning of the next similar pulse in the same direction.

PULSING — A method of operating magnetic and acoustic sweeps in which the sweep energised by current which varies or is intermittent in accordance with a predetermined schedule.

RADAR BUOY RUNNING — A method of navigating by using radar to keep the required distance from a line of mine warfare buoys.

RELEASE DELAY — A device fitted to moored mines or sinkers to delay the rising of the mine case, either for a preset interval or until the influence of a passing target or sweep is received.

RESONANT FREQUENCY — The resonant frequency of an object is the frequency at which it will vibrate when struck when free to do so.

RIPE MINE — See Armed Mine.

ROUTE — The prescribed track over the ground to be followed from a specific point of origin to a specific destination. A sea route has no width and shipping must keeping to the track over the ground.

RUN — The transit of an MCMV and MCM gear combination along a track.

SAFE CURRENT — In naval mine warfare the maximum current that can be supplied to a sweep in a given waveform and pulse cycle that does not produce a danger area to the MCMV with respect to the mines being swept for.

SAFE DEPTH	A self protection depth which is the shallowest depth of water in which a vessel will not actuate a ground mine of the type under consideration. Safe depth is usually quoted for conditions of the vessel upright, calm sea and a given speed. See also Self Protection Depth.
SAFE DISTANCE	The horizontal range from the edge of the damage area to the centre of the sweeper.
SAFE SPEED	The speed at which a particular ship can proceed without actuating a given influence mine, within the damage area at the depth under consideration.
SEARCHED CHANNEL	The whole or part of a route or a path which has been searched, swept or hunted, the width of the channel being specified.
SELF PROTECTION DEPTH	The depth of water where the aggregate danger width relative to mines affected by the minesweeping technique is ZERO.
SELF PROTECTION OUTPUT CONDITIONS	Where the output of the sweep is reduced sufficiently to give safety to the sweeper from the mines being swept for.
SELF PROTECTIVE MEASURES	Measures taken by all vehicles to reduce the risk from mines whilst in mineable waters.
SELF-SINKING BUOY	A buoy equipped with a flooding mechanism in order to sink the buoy case after a predetermined time.
SENSITIVE MINE	A sensitive mine is one whose detecting circuit requires a relatively small magnitude of influence (as from a slow, small, quiet and degaussed vessel) to actuate it.

SENSITIVITY — The sensitivity of an influence mine circuit is a term descriptive of its liability to actuation by an influence field; the higher the sensitivity, the smaller the magnitude of the influence required. It is a qualitative term and if a measurement is to be included the specific term, eg actuation level, should be included.

SEQUENCE CIRCUIT — A circuit which requires actuation by a predetermined sequence of influences of predetermined magnitudes.

SERVICE MINE — A mine capable of a destructive explosion.

SHIP COUNTER — A device in a mine which prevents the mine from detonating until a preset number of actuations has taken place. (A ship count setting of NONE means that the mine will fire at the next actuation).

SHIP INFLUENCE — In naval mine warfare the magnetic, acoustic and pressure effects of a ship, or a mine sweep simulating a ship, which is detectable by a mine or other sensing devices.

SHORT SCOPE BUOY — A buoy used as a navigational reference. It is designed to remain vertically over its sinker and its watch circle radius does not exceed 30 per cent of the water depth.

SIGNALLED SPEED — The speed in knots at which the guide has been ordered to proceed. In mine warfare the signalled speed is attained by using the normal number of revolutions/value of pitch for the ordered speed, adjusting as necessary for foul bottom and danger, but not adjusting for MCM gear streamed.

SIGNATURE — The characteristic pattern of the target's influence as detected by the mine.

EXTAC 1007