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A METHODOLOGY FOR ALLOCATING TRAINING AMMUNITION RESOURCES IN A MULTI-ENVIRONMENT BUDGET

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A METHODOLOGY FOR ALLOCATING TRAINING AMMUNITION RESOURCES IN A MULTI-ENVIRONMENT BUDGET

by

Dr. A. Jesion

FEBRUARY 1996

OTTAWA, CANADA

National Defence Défense nationale

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ABSTRACT

NDHQ has recently conducted a Zero-Based Ammunition and Sonobuoy Review in which steady state, transitional, and opstock ammunition requirements were determined. NDHQ Instruction VCDS 7/95 established the Ammunition and Sonobuoy Control Board (ASCB) to replace the Ammunition Planning Working Group (APWG) and the Ammunition Advisory Group (AAG). At its first meeting in October of 1995, the ASCB requested that the Director Mathematics and Statistics work on the development of methodology for possible use in the allocation of resources to meet the ammunition requirements of the Canadian Forces. This Research Note presents a proposal for such a methodology.

ACRONYMS

AAW	Anti-Air Warfare
AOR	Auxiliary Oiler Replenishment (Ship)
APWG	Ammunition Planning Working Group
Arty	Artillery
ASuW	Anti-Surface Ship Warfare
ASW	Anti-Submarine Warfare
ASCB	Ammunition and Sonobuoy Control Board
CFD	Chief Force Development
CFDP	Canadian Forces Development Plan
Col/CA	Collective/Combined Arms
Comms	Communications
DDP	Defence Development Plan
DDPG	Defence Development Planning Guide
D Force S	Director Force Structure
DMC	Defence Management Committee
DND	Department of National Defence
DRCD	Defence Resources Coordination Document
FFH	Helicopter (equipped) Frigate
IIT	Individual Initial Training
IRT	Individual Refresher Training
IST	Individual Special Training
mm	Millimetre
MOC	Military Occupation
MP	Military Police
NDHQ	National Defence Headquarters
Sqn	Squadron
Trg	Training

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A METHODOLOGY FOR ALLOCATING TRAINING AMMUNITION RESOURCES IN A MULTI-ENVIRONMENT BUDGET

INTRODUCTION

Background

1. In January of 1993, the Defence Management Committee (DMC) approved a ten percent reduction in the planning allocation for ammunition and sonobuoys, to commence in FY96/97. The Chief Force Development (CFD) was directed to examine the validity of that ten percent reduction and to report back to the DMC on the implications of such a policy.

2. CFD established the Ammunition Planning Working Group (APWG) which was tasked to review stockpiling criteria and to determine the validity of the ten percent reduction to ammunition funding. Chaired by the Director Force Structure (D Force S), the APWG membership included representatives from the Commands as well as Materiel Group agencies associated with ammunition.

3. The APWG carried out a Zero-Based Ammunition Review which was eventually broken down into two separate reviews: the Opstock Review to determine ammunition requirements for actual operations and the Steady State Review to determine the annual (i.e. steady state) ammunition requirement which is primarily associated with training.

4. Reference 1 reported the results of the Zero-Based Review, taking into account departmental guidance documents which have been published in the interim - CFDP 92, DDP 93, and the 1994 Defence White Paper. Although the missions and tasks generally

have remained the same throughout, the requirement to provide training for an increase to the Land Forces as a result of the 1994 Defence White Paper was not included in Reference 1.

5. Reference 2 presented a preliminary analysis of the Zero-Based Review methodology with particular emphasis on determining the extent to which "high cost" ammunition natures drive total training costs with respect to annual ammunition usage. ("High cost" items include ammunition natures with low unit cost and high consumption as well as the other way around.) All input data for that paper were taken from the Zero-Based Review and its supporting documentation, obtained primarily from D Force S staff. It was shown that relatively few ammunition natures tend to dominate the steady state ammunition budget.

6. Reference 3 formally established the ASCB with a mandate to manage the department's ammunition budget from a central, "purple" perspective. Although much information exists within each Command about training ammunition requirements for their personnel and units, decisions must also be made centrally concerning the size of the "pie slice" allocated to each Command. In this context, at its first meeting in October of 1995, the ASCB requested that the Director Mathematics and Statistics work on the development of methodology for possible use in the allocation of ammunition resources between environments, i.e. at a centrally-managed level within DND as a whole. This was confirmed as a requirement at the ASCB Ammunition Allocation Meeting of 29 November 1995.

Some Definitions

7. As described in Reference 3, ammunition and sonobuoys are now divided into three types of stocks: steady state, transition, and opstocks. Steady state ammunition primarily represents the annual training ammunition required to meet the readiness levels

detailed in the DDPG. Transition stocks are the ammunition levels required for a force to make the transition from its steady state to a higher level of operational capability required to carry out an assigned mission or task. Opstock ammunition represents the ammunition needed to support forces in the execution of operations.

8. When a military unit or group is designated to be at a "lower" readiness level, the actual amount of training done by this unit/group is often reduced in some fashion. On the other hand, when a unit/group is carrying out certain kinds of operations (such as "peacekeeping") the consumption of ammunition usually goes down as well. These are but two of many factors which significantly affect training ammunition usage. While training standards for most personnel are Command responsibilities, the supply of ammunition which may be required to satisfy these requirements is affected by budget restrictions which are centrally managed at NDHQ.

Purpose

9. This paper presents a proposal for a methodology which may be applicable to support central management of training ammunition resources. Such a methodology (or its derivatives) may be used to support decision-making with respect to the division of the total departmental ammunition budget amongst the Commands. It is in this area that the development of decision support tools has been requested by the ASCB.

Scope

10. This paper outlines a methodology which could be used to evaluate proposals for allocating resources to the environmental Commands on a rational, objective basis. It is based on obtaining the maximum training benefit from each block of ammunition as it is allocated on a unit-to-unit basis. The methodology is based on the assumption that "equivalent" units can be defined both within an environment and between environments.

Only the methodology is described (together with simple illustrative examples). If the approach is deemed useful, much work would remain to produce relevant unit and training "definitions" for use in this methodology. Readiness policies, training standards, and procedures would have to be taken into account.

THE AMMUNITION ALLOCATION MODEL

Some Assumptions

11. Before describing the methodology, certain assumptions (both implicit to the methodology and explicitly stated later on in this paper) should be listed:

a. only (annual) training ammunition costs are included in the model;

b. ammunition is taken to include all expendables (e.g. chaff, flares, smoke, etc.) as well as sonobuoys required for annual unit or sub-unit training, as determined by the environmental Commands;

c. the ammunition budget is centrally managed (before allocation to the Commands, at least) and costs are directly "measurable" whenever ammunition is used for training;

d. ammunition costs are proportional to expenditures, i.e. "twice as much ammunition costs twice as much to buy". Thus, economies of scale when purchasing ammunition are not explicitly taken into account;

e. ammunition benefits (i.e. the value of training which requires ammunition expenditure) are linearly dependent on the amount of ammunition expended. Since this is in fact not usually true, the

methodology allows for multiple training standards so that the value of the ammunition expenditure is linear within "training bands" only, rather than all the way from initial to advanced training; and

f. military forces can be defined on a unit or sub-unit basis which have "equal" utility, value, functionality, etc. across environmental boundaries. (Perhaps this is the most difficult assumption to make!)

The Model

12. Let TC = the total annual ammunition cost required to train all military units and sub-units as well as individual personnel to carry out all approved missions/tasks of the Canadian Forces as set out by departmental policy. TC can be expressed as a sum of the environmental ammunition costs plus common user costs as follows:

$$TC = IC + TC_M + TC_L + TC_A + TC_C \qquad (1)$$

where

IC is the sum of all annual individual personnel training ammunition costs (including initial, refresher, and specialist training);

TC_M = the annual cost of all ammunition required by maritime personnel and units to conduct maritime training (which may include annual obligations such as trials, test and evaluation, competitions, etc.);

TC_L = the annual cost of all ammunition required by land forces personnel and units to conduct land force training and to satisfy other annual obligations, etc.;

TC_A = the annual cost of all ammunition required by air personnel and units to conduct air force training and to satisfy other annual obligations, etc.; and

TC_C = the annual cost of steady state common user ammunition for training and other functions. The annual cost of all ammunition required to train military units specifically for joint operations plus ammunition required for "support units" to train for their missions/tasks is included here. (In an alternative to this formulation, these costs could have been allocated to the individual environmental totals.)

13. In some instances, more than one unit may derive training benefit from the same expenditure of ammunition. For example, the same artillery fire can be used to train artillery gun crews and helicopter forward observers who direct gunfire. In such cases, care must be taken not to double count ammunition usage. The same can be said of ammunition which serves to train individuals to a particular level and at the same time raise unit training to a particular standard. (If required, separate "terms" can be placed in equation (1) to represent this type of multi-function ammunition expenditure. An amount equal to all double-counted ammunition can then be subtracted from the total.)

14. Say that the cost of one "round" of ammunition of type "i" used to train the "p th" member of the Canadian Forces is C_{pi}. Further, say that the annual number of "rounds" of ammunition of type "i" required to train the "p th" individual in trade or occupation "j" (to some training standard "k") is N_{pijk}. Also, let the annual cost of individual training ammunition of type "i" which is "wasted" for one reason or another (e.g. shelf life expiry) be WC_i. Then IC can be written explicitly as follows:

$$IC = \sum_{i}^{\text{all ammo types}} WC_i + \sum_{p}^{\text{all personnel}} C_p \qquad (2)$$

where

$$C_p = \sum_{i}^{\text{all ammo types}} \sum_{j}^{\text{all trades}} \sum_{k}^{\text{all training standards}} C_{pi} * N_{pijk}$$

15. The summations in equation (2) are over all required ammunition types which are relevant to the individual's trade/employment, all trades which require ammunition expenditures for trades training, and all acceptable training standards. (The large majority of such ammunition falls into the "Land and Common User" category.) An example meant to illustrate equation (2) is given in Table I below which would represent only a very small portion of the entire data requirement. Although the values for indices "j", "k" and "l" are representative, "i" has been taken to be the Defence Resources Coordination Document (DRCD) ammunition nature serial number.

TABLE I

A REPRESENTATIVE EXAMPLE OF A PORTION OF THE INDIVIDUAL TRAINING EQUATION

Training Standard (k) for MOC (j)	Required Training Ammunition Type (i)	Single Round Cost for Ammunition Type (i)	Required Expenditure (Rounds) N_{pijk}	Cost/MOC (j), Standard (k) & Ammunition (i)
Qualification (say k=1) Infantry (say j=1)	Cart 5.56mm Ball C77 (say i=0060)	$0.73	222/soldier	$162
Refresher Trg (say k=2) Infantry (say j=1)	Cart 5.56mm Ball C77 (say i=0060)	$0.73	422/soldier	$308
Qualification (say k=1) Artilleryman (say j=2)	Cart 5.56mm Ball C77 (say i=0060)	$0.73	133/soldier	$97
Refresher Trg (say k=2) Artilleryman (say j=2)	Cart 5.56mm Ball C77 (say i=0060)	$0.73	376/soldier	$274

16. For the maritime environment, say that the cost of one "round" of maritime ammunition of type "i" is C_{Mi}. Further, say that the annual number of "rounds" of maritime ammunition of type "i" required to train one maritime unit of type "j" (to training standard "k") which expends that nature of ammunition is N_{Mijk}. Also, let the annual cost of maritime ammunition of type "i" which is "wasted" for one reason or another (e.g. shelf life expiry) be WC_{Mi}. Then

$$TC_M = \sum_{i}^{\text{all ammo types}} WC_{Mi} + \sum_{i}^{\text{all ammo types}} \sum_{j}^{\text{all trades}} \sum_{k}^{\text{all training standards}} C_{Mi} * N_{Mijk} \quad (3)$$

Note that M is used as an index to remind us that we are dealing with maritime ammunition.

17. The cost of individual personnel training (such as small arms training) is included in the IC term, equation (2) above, as the large majority of such ammunition falls into the "Land and Common User" category. An example meant to illustrate equation (3) is given in Table II below.

TABLE II

A REPRESENTATIVE EXAMPLE OF A PORTION OF THE MARITIME TRAINING EQUATION

Training Standard (k)* for Ship Type (j)	Required Training Ammunition Type (i)	Single Round Cost for Type (i) Ammunition C_{Mi}	Required Expenditure (Rounds) N_{Mijk}	Cost/Ship (j), Standard (k) & Ammunition (i)
H10 (say k=1) FFH (say j=1)	57mm NFVT (say i = 3175)	$1094	50	$54,700
H30 (say k=2) FFH (say j=1)	57mm NFVT (say i = 3175)	$1094	40	$43,760
N30 (say k=3) FFH (say j=1)	57mm NFVT (say i = 3175)	$1094	25	$27,350

* In this example, readiness "definitions" are used for illustrative purposes.

18. For the land environment, say that the cost of one "round" of land force ammunition of type "i" is C_{Li}. Further, say that the annual number of "rounds" of land force ammunition of type "i" required to train one land force unit/sub-unit/crew of type "j"

(to training standard "k") which expends that nature of ammunition is N_{Lijk}. Let the annual cost of land force ammunition of type "i" which is "wasted" for one reason or another (e.g. shelf life expiry) be WC_{Li}. Then

$$TC_L = \sum_{i}^{all\ ammo\ types} WC_{Li} + \sum_{i}^{all\ ammo\ types} \sum_{j}^{all\ trades} \sum_{k}^{all\ training\ standards} C_{Li} * N_{Lijk}. \quad (4)$$

As in equation (3), L is used to denote land force ammunition usage.

19. Equation (4) is applicable to vehicle/group/sub-unit/unit training while the cost of individual personnel training (such as small arms training) is included in the IC term, equation (2), above. An example meant to illustrate equation (4) is given in Table III below.

TABLE III

A REPRESENTATIVE EXAMPLE OF A PORTION OF THE LAND FORCE TRAINING EQUATION

Training Standard (k) for Sub-Unit Type (j)	Required Training Ammunition Type (i)	Single Round Cost for Type (i) Ammunition C_{Li}	Required Expenditure (Rounds) N_{Lijk}	Cost/Sub-Unit (j), Standard (k) & Ammunition Type (i)
Refresher Trg (say k=2) Field Arty (say j=5)	105mm HE PD(How) (say i=0560)	$630	200/Howitzer	$126,000
Special Trg (say k=3) Field Arty (say j=5)	105mm HE PD(How) (say i=0560)	$630	120/Howitzer Meritt Competition	$75,600

20. For the air environment, say that the cost of one "round" of air force ammunition of type "i" is C_{Ai}. Further, say that the annual number of "rounds" of air ammunition of type "i" required to train one unit of type "j" (to training standard "k") which expends that nature of ammunition is N_{Aijk}. For air forces, the total steady state ammunition cost can be written as follows:

$$TC_A = \sum_{i}^{all\ ammo\ types} WC_{Ai} + \sum_{i}^{all\ ammo\ types} \sum_{j}^{all\ trades} \sum_{k}^{all\ training\ standards} C_{Ai} * N_{Aijk} \qquad (5)$$

where the annual cost of air force ammunition of type "i" which is "wasted" for one reason or another (e.g. shelf life expiry) is WC_{Ai}. Once again the index A is only used to refer to air force ammunition requirements.

21. The cost of individual personnel training (such as small arms training) is included in the IC term, equation (2) above. The large majority of such ammunition falls into the "Land and Common User" category. An example meant to illustrate equation (5) is given in Table IV below.

TABLE IV

A REPRESENTATIVE EXAMPLE OF A PORTION OF THE AIR FORCE TRAINING EQUATION

Training Standard (k) for Unit Type (j)	Required Training Ammunition Type (i)	Single Round Cost for Type (i) Ammunition C_{Ai}	Required Expenditure (Rounds) N_{Aijk}	Cost/Unit (j), Standard (k) & Ammunition Type (i)
Normal (say k=1) Fighter Sqn (say j=1)	Flare MJU 8A/8B (say i=5335)	$73.10	2000	$146,200
Normal (say k=1) Transport Sqn (Say j=3)	Flare MJU 8A/8B (say i=5335)	$73.10	500	$36,550

22. Let the cost of 1 "round" of any common usage ammunition of type "i" be C_{Ci}. Let the annual number of "rounds" of common usage ammunition of type "i" required to train one air/land/maritime/"other" unit of type "j" (to training standard "k") which expends that nature of ammunition be N_{Cijk}. Further, let the annual cost of common usage ammunition of type "i" which is wasted for one reason or another (e.g. shelf life expiry) be WC_{Ci}. Then

$$TC_C = \sum_{i}^{all\ ammo\ types} WC_{Ci} + \sum_{i}^{all\ ammo\ types} \sum_{j}^{all\ trades} \sum_{k}^{all\ training\ standards} C_{Ci} * N_{Cijk}. \quad (6)$$

Once again, the index C is only used to refer to the common user ammunition.

23. An example meant to illustrate equation (6) is given in Table V below. Care must be taken not to double count ammunition as the same ammunition nature which is used in individual training (see equation 2) can also be used for unit/sub-unit training in equation (6).

TABLE V

A REPRESENTATIVE EXAMPLE OF A PORTION OF THE COMMON USER TRAINING EQUATION

Training Standard (k) for Unit Type (j)	Required Training Ammunition Type (i)	Single Round Cost for Type (i) Ammunition C_{Ci}	Required Expenditure (Rounds) N_{Cijk}	Cost/Unit (j), Standard (k) & Ammunition Type (i)
Collective Trg (say k=3) Comms Sqn (say j=15)	5.56mm Ball Trg Pack (say i=0059)	$0.70	20000	$14,000
Collective Trg (say k=3) MP Platoon (say j=16)	5.56mm Ball Trg Pack (say i=0059)	$0.70	100000	$70,000

AN ILLUSTRATIVE EXAMPLE

24. The following example is purely illustrative and is not based on actual training requirements for Land Force personnel or units.

25. Consider one particular type of Land Force ammunition which costs $100 per round (i.e. using the notation of equation (4), C_{Li} = $100). It is used exclusively by Land Force Sub-Units (Types "j=1" and "j=2"). In this example, it will be assumed that these types of Sub-Units may train to three different "standards". Say that the annual number of rounds (N_{Lijk}) of this particular type of ammunition required to train these Land Force Sub-Units to high ("k"=1), normal ("k"=2), or low ("k"=3) standards is given in Table VI below, using the notation of equation (4). Please note that in this example, the annual ammunition allocation is considered cumulative, so that (for example) while each of the 8 Type "1" Sub-Units which train to the "low standard", require 10 rounds for their training, such a Sub-Unit would require 70 more rounds to train to the "normal standard", for a total of 80 rounds, etc.

TABLE VI

SAMPLE DATA: THE NUMBER OF ROUNDS REQUIRED TO TRAIN INDIVIDUAL SUB-UNITS TO PARTICULAR TRAINING "STANDARDS"

	Land Force Type "j=1"	**Land Force Type "j=2"**
Standard (k)	Total = 72 Sub-Units	Total = 100 Sub-Units
	Required Ammunition	Required Ammunition
"high" (say k=1)	100 (for 48 of 72 Sub-Units) (i.e. N_{Li11} = 100)	300 (for 70 of 100 Sub-Units) (i.e. N_{Li21} = 300)
"normal" (say k=2)	80 (for 16 of 72 Sub-Units) (i.e. N_{Li12} = 80)	100 (for 20 of 100 Sub-Units) (i.e. N_{Li22} = 100)
"low" (say k=3)	10 (for 8 of 72 Sub-Units) (i.e. N_{Li13} = 10)	50 (for 10 of 100 Sub-Units) (i.e. N_{Li23} = 50)

26. Using the data from Table VI, the annual cost of training all the above units to the indicated training standards is as follows:

$$\left(48^{*}N_{Li11}+16*N_{Li12}+8^{*}N_{Li13}\right)^{*}C_{Li} + \left(70^{*}N_{Li21}+20*N_{Li22}+10^{*}N_{Li23}\right)^{*}C_{Li}$$

$$= (48^{*}100+16^{*}80+8^{*}10)^{*}\$100 + (70^{*}300+20^{*}100+10^{*}50)^{*}\$100$$

$$= \$2,966,000.$$

27. Say that consideration was being given to training all these Sub-Units to the "high standard" (k=1). The annual cost of training all these Land Force Sub-Units (Type 1 and 2) to the "high standard" (k=1) would then be:

$$\left(72^{*}N_{Li11} + 100*N_{Li21}\right)^{*}C_{Li}$$

$$= (72^{*}100 + 100^{*}300)^{*}\$100 = \$3,720,000.$$

28. If all of the $754,000 difference between "current" and "proposed" funding levels were available for an annual expenditure on this particular nature of ammunition, then all Sub-Units could be trained to the "high standard". Some intermediate strategy for ammunition allocation could be adopted if less than this amount is available as discussed in the following paragraph.

29. The ammunition cost (with respect to this nature only) of bringing one Land Force Type "1" Sub-Unit up from "normal" to "high" is (100-80)*$100 = $2000 and from "low" to "normal" is (80-10)*$100 = $7000. For Type "2" Sub-Units, the cost of bringing one Sub-Unit from "normal" to "high" is 200*$100 = $20,000 and 50*$100 = $5000 in going from "low" to "normal". In this case, assuming all Sub-Units to be of equal utility, the "greatest" benefit is obtained by allocating training ammunition of this type to bring Type "1" Sub-Units from "normal" to "high" - at $2000 per Sub-Unit. This would be followed by allocating ammunition for training Type "2" Sub-Units from "low" to "normal" - at $5000 per Sub-Unit, etc. This is illustrated in Figure 1 below.

30. The implicit assumption made in this example is that the training standards are all equally valid as "end" states for the annual training activity for these unit types. There are also assumptions embedded here that the units can accommodate the extra ammunition for their training and therefore no facilities or time constraints enter into the model (at this stage of its development).

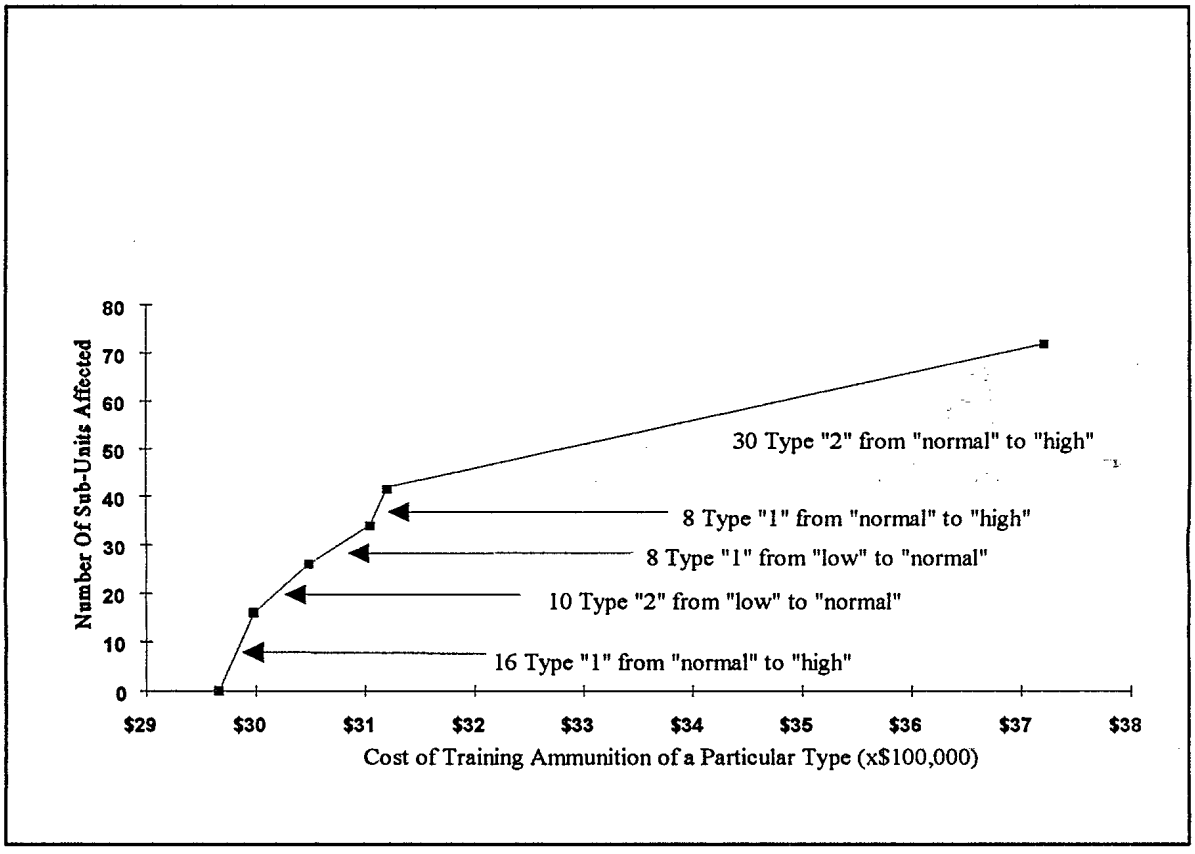

Figure 1: Example of Ammunition Allocation

ALGORITHM FOR "GLOBAL" AMMUNITION ALLOCATION

31. The above example may be generalized to an ammunition resource allocation methodology by following similar steps on a more "global" level. The steps can be written as follows:

a. divide forces under review into "equivalent" units, sub-units,..;
e.g. Units A, B, and C

b. Define appropriate, relevant training standards for these units;
e.g. high (able to carry out ....);
medium (able to do ...); and
low (able to provide ...)

(OPTIONAL STEP (c))[1]

c. Allocate ammunition to units which fulfill minimum requirements on the tasks and missions list (i.e. achieve minimum training standards);
e.g. "w" Type 1 for Unit A or "x" Type 1 for Unit B

d. List all ammunition allocation possibilities which result in "transitions" from one training standard to a higher standard;
e.g. "y" Type 1 and "z" Type 2 for Unit A to go from low to medium training standards.

e. Choose the least cost allocation which raises one equivalent unit to a higher training standard;

---

[1] This step may be required to ensure that ammunition is allocated to train certain units for essential missions, roles, or activities.

f. If the ammunition budget is used up, then the process is finished. If not, then subtract the allocated funds from the budget envelope and eliminate the allocation option from the list; and

g. Go to step e.

DISCUSSION

Individual Training

32. The algorithm described above may be easier to apply to individual training than to unit training. For example, resource allocation directly proportional to the number of members to be trained may be suitable for allocating small arms ammunition to the Commands. Higher ammunition usage for certain MOCs must be included in the summations for all personnel to reach the required standards. (For example the Zero-Based Review carried out such a bottom-up determination of annual training ammunition requirements, based on CFDP 92 and DDP 93 as modified by the 1993 readiness and sustainment policy.) When members from any particular MOC are distributed between Commands, care must be taken to apply training standards uniformly. For example, it is not unusual for an admin clerk who has received initial training on the C7 rifle within LFC to use considerably less ammunition for his or her refresher training if they are now working at an AIRCOM unit.

33. When the methodology is applied to groups or units, a major difficulty becomes the determination of "equivalent units" to form the basis of subsequent cost comparisons. Criteria for equivalence can include personnel strength, mission criticality, uniqueness, or other military judgements concerning utility.

Maritime Forces

34. For Maritime Forces, the obvious "equivalent unit" is a ship. However, all ships are not equal! Is a frigate equal to a destroyer in value, and how does an AOR, submarine or a minor war vessel equate? The priority for ammunition allocation might be set for the frigates, destroyers, and submarines which must maintain high readiness. Other units might have secondary call upon "group" ammunition resources.

35. Unit, collective, or group training tasks which use up ammunition include Anti-Air Warfare (AAW), Anti-Surface Ship Warfare (AsuW), and Anti-Submarine Warfare (ASW) operations team training. In view of the findings in Reference 2, only a few high cost items need to be examined in a "first cut". These are primarily in the AAW area as torpedoes (the high cost ASW weapons) have not been included in the annual training budget (i.e. they are all now opstocks).

Land Forces

36. To define Land Force units with equivalent utility (in their respective roles), it may be necessary to use the infantry battalion, artillery battery, or armoured regiment as the unit equivalent to the frigate/destroyer of the Maritime Forces. (At a higher level, the brigade group might be compared to a squadron of ships.)

37. In the Zero-Based Review, all Land Forces training activities were divided into four major categories: individual initial training (IIT), individual refresher training (IRT), individual special training (IST), and collective/combined arms training (Col/CA). As the largest ammunition expenditures appear to be allocated for IIT and IRT, these must be rolled up to the unit level for comparative purposes. Then the question becomes (once IIT and IRT are added up to infantry battalion or artillery regiment levels), how do Land

Force unit training ammunition costs compare with the ammunition costs associated with training the crew of a frigate? Should the higher capital cost in the ship's case be taken into account?

Air Forces

38. In any comparison with Maritime Forces (based on major warships) and Land Forces (based on infantry battalions, etc.) the logical comparable Air Force unit would be the squadron. Fighter squadrons expend considerably more ammunition than others and so may be the prime concern in this sort of ammunition allocation problem. (Maritime Air squadrons also should be considered in the first approximation as they may expend considerable numbers of sonobuoys for their training.) The same concerns about equivalency, numbers of personnel, high equipment capital costs, etc. as noted above, remain issues to be resolved.

Joint Force Ammunition Requirements

39. Are there any "Joint Force" ammunition requirements? It may be possible to ignore this part of the problem if ammunition expenditures are all grouped under the environmental Commands. For example, certain natures of small arms ammunition could be included in such a categorization for such missions as "Peace Support" operations. Certain ammunition natures such as Mk 46 torpedoes could be considered in this category as some are employed by Maritime Air squadrons while others are ship launched. However, in this particular case, they are considered to be in the Opstock rather than annual training category (Reference 1).

SUMMARY

40. This paper has introduced a methodology which may have value in supporting decision-making with respect to allocation of training ammunition on a multi-environmental basis. The methodology is inherently simple (being based on straight summations of ammunition costs) and visible - depending upon explicit definitions of units, training standards, and the ammunition required for personnel and units to satisfy their training standards. However, problems are anticipated in the development of equivalency assessments between units which cross environmental boundaries.

41. Reference 2 showed that as few as 55 ammunition natures account for approximately 80% of the annual (steady state) ammunition requirement for all the Commands combined. Thus, it may be possible to achieve useful results by combining a "high-level" allocation model (i.e. at the level of ships, battalions, air squadrons, etc.) with relatively few ammunition "cost drivers".

REFERENCES

1. Zero-Based Ammunition and Sonobuoy Review Report to DMC, 11300-1 (D Force S) dated May 95

2. Cost Drivers in Steady State Ammunition Requirements, DMS Research Note RN 9504, by Dr A. Jesion, December 1995.

3. 11300-1 (VCDS) 12 October 1995 - NDHQ Instruction VCDS 7/95.

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NDHQ has recently conducted a Zero-Based Ammunition and Sonobuoy Review in which steady state, transitional, and opstock ammunition requirements were determined. NDHQ Instruction VCDS 7/95 established the Ammunition and Sonobuoy Control Board (ASCB) to replace the Ammunition Planning Working Group (APWG) and the Ammunition Advisory Group (AAG). At its first meeting in October of 1995, the ASCB requested that the Director Mathematics and Statistics work on the development of methodology for possible use in the allocation of resources to meet the ammunition requirements of the Canadian Forces. This Research Note presents a proposal for such a methodology.

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