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ORDNANCE/SUPPLY & TRANSPORT ELECT & MECH

CAPTAIN TO MAJOR WRITTEN PROMOTION EXAMINATION DIRECT REGULAR COMMISSION OFFICERS

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NIGERIAN ARMY ORDNANCE CORPS

INTRODUCTION

1. The requirement for loading of equipment's can be traced to when man identified the need to fend and protect himself. Almost everything that the Army needs to live, move and fight is provided by the Nigerian Army Ordnance Corps (NAOC).

2. This paper reviews the depot organization and the role of NAOC. It however, covers and outlines a large and complex group of topics as it has to be of a manageable length. Reference materials are available in most units, formations and libraries to consult for additional information.

AIM

3. The aim of this note is to provide revision topics for NAOC officers preparing for Captain to Major Written Promotion Examination (CMWPE).

ROLES OF NAOC

4. The NAOC Roles are:
   a. To provide Ordnance Stores and equip the Army.
   b. To inspect and repair:
      (1) Ammunition.
      (2) General and Textiles including tentages.
      (3) General stores including furniture.
   c. To provide a range of specialist services:
      (1) Printing.
      (2) Laundry and bathing facilities.
      (3) Disposal of Improvised Devices (IED) and ammunition.

(4) Savage of metals and stores.

ORDNANCE MATERIAL

5. The items NAOC provides are:

a. Ammunition.

b. Clothing and general stores.

c. Vehicles (A,B,C, D & E).

d. Mechanical transport spares and technical stores.

6. After reading the above paragraphs, officers are required to know the following:

a. The roles of NAOC.

b. The material NAOC provides.

BASIC PROVISIONING

7. **Acquisition of Stores**. The acquisition of stores to equip and maintain the Army starts with provision which is defined below:

8. **Definition**. Provision is defined as the process of calculating and obtaining ordnance stores required for the initial equipping and subsequent maintenance of the Army.

Objective of Provision. The objective of provision is to provide the right store in the right condition, in the right quantity, at the right place at the right time and in the most economical manner. Provision is carried out at 3 levels:

a. **Primary Provision**. The primary provision takes account of Army and estimate customers. It is done at HQ DOAL, in conjunction with HQ NAOC and the Central Depots concerned.

b. **Secondary Provision**. Secondary Provision is confined to the requirements of a specified dependency.

c. **Tertiary Provision**. Tertiary Provision is carried out by Ordnance Field Park (OFP) and store section attached to NAEME Workshops.

d. **Provision Division**. There are 2 divisions of stores for provision purposes:

(1) Wastage Rate Provision Items.

(2) Usage Rate Provision Items.

e. Items for which wastage rate provisions have one or more of the following characteristics:

(1) They are maintained in the service by repair and overhaul.

(2) They are of high operational importance.

(3) They are expensive.

(4) They are difficult to procure from industry because of design, specification or due to small quantities involved.

(5) These are some of such items; Armament, engineering equipment and communication equipment.

MANAGEMENT DIVISIONS

10. The main divisions of the management of Ordnance Stores are as follows:

a. **MT Spares and Technical Stores**. This management deals with all spare parts related to mechanical transport and all stores, equipment of technical nature e.g. Armament, radios, optical equipments, and the spare parts to support them.

b. **Clothing Stores**. Clothing Stores includes all items used by a service man from headgear to foot ware both inner and outer.

c. **General Stores**. General Stores include nonpowered tools an workshop materials.

d. **Ammunition and Vehicles**. Ammunitions and Vehicles are the other divisions of the stock management.

e. At this stage officers are required to know the following:

(1) Provision, definition, objective and level.

(2) The main divisions in the management of Ordnance Stores.

DEPOT ORGANIZATION AND LAYOUT

11. All the management divisions are carried out in the NAOC depots. The layout of a depot is mainly determined by the types and sizes of stores it holds. The depots are listed below:

a. Central Ordnance Depots (CODs).
b. Central Ammunition Depot (CAD).
c. Central Vehicle Depot (CVD).
d. Base Ammunition Depots (BADs).
e. Base Ordnance Depot (BODs).
f. Ammunition Sub-Depots (ASD).

12. Ordnance Field Park (OFP) and Workshop Stores section are field units. They carryout tertiary provision but mainly provide NAOC support to the formation they are affiliated. Officers are required to know the organization of the following:

a. BOD.
b. BAD.
c. OFP.

STORES AND STORE HOUSE MANAGEMENT

13. The following functional procedure, takes place in all depots:

a. Basic provisioning.
b. Receipt procedure.
c. Issue procedure.
d. Dues in and dues out procedures.
e. Stocktaking and reconciliation procedure.

f. Care, preservation and packaging of stores.

14. **Receipt Procedure**. The basic requirements of receipt procedure are as described below:

a. Quick clearance of the transport which delivers the stores to the depot.

b. Ensure that efficient checks are made as to the designation, quality, quantity and condition of stores and packages against receipt document.

c. Maintenance of consignment identity while it awaits complete receipt.

d. Ensure that when stores are put into stock they are in condition fit for storage and issue.

e. Ensure that stores are located in such a way that no time is lost when they are required for issue.

f. Ensure that stores are properly brought to accounts.

ISSUE PROCEDURE

15. Issue procedure is one of the main functional procedures in Ordnance depot. The basic requirement of issue procedures are designed to ensure prompt action:

a. In controlling of all damaged documents checked for errors.

b. Thorough checking of unit entitlement and proper classification of indent into normal or special.

c. Correct selection of stores, proper packing and distinctive marking of all consignment.

d. In accordance with demands dues out to be in their chronological order.

e. Proper documentation at each stage.

f. Immediate dispatch to unit.

STOCKTAKING AND RECONCILIATION PROCEDURE

16. Stocktaking is a process of physical verification of stores and reconciling the difference between the actual holding and account card balances in order to make the latter a correct index of the stock held in an ordnance depot.

17. **Aim of Stocktaking**. Stocktaking is aimed at establishing and maintaining a sound material management in units, specifically it is aimed at:

a. Curbing theft.

b. Ensuring the maintenance of proper stores account at all times.

c. Facilitating write off actions where necessary.

d. Detecting fraud (if any).

e. Providing training for staff.

18. **Advantages of Stock-Taking**. Stock-taking has the following advantages amongst others:

a. Frauds can be easily detected.

b. It ensures, stores are properly accounted for at all times, thus regularizing accounts.

c. It makes write-off action possible.

d. Makes replacement of certain deficiencies possible.

e. Makes auditing easy.

19. **Basic Requirements**. The basic requirement of stocktaking is:

a. All stocks of an item are located and counted.

b. All accounts are updated before physical stocks and account card balances are compared to ensure the discrepancies revealed are not fictitious.

c. The normal flow of work is interrupted for as short a

period as possible including cases for reaccount.

d. The checks proceed from stores to accounts and not vice versa.

e. Attention to items is selective and frequency of stocktaking is related to the importance and value of the items.

f. At the end of it the account should reflect, the position of the stock existing on the ground.

20. **Types of Stocktaking**. There are three types of stocktaking in both the NAOC and units. These are:

a. **Cyclic Stocktaking**. Under the cycle stocktaking physical quantity/quality of each item is physically verified once within a cycle of time. The cycle could be half yearly, or of a longer duration depending on the size of the stores. In units the decision as to the interval is the CO's.

b. **Special Stocktaking.** The special stocktaking relates to the physical verification of the quantity and quality of valuable and or attractive items at irregular intervals as ordered by the CO. A special stocktaking may also take place in respect of all items during a hading / tarking over exercise.

c. **Secondary Stocktaking**. A secondary stocktaking is usually carried out when it is suspected or known that physical Qty or quality of an item does not agree with account ledge's entry. This short fall in quantity and quality may be due to:

(1) Theft (Suspected).
(2) Suspected Fraud.
(3) After flood.
(4) Fire outbreak.
(5) Evaporation/teaking.
(6) Weather.

21. At this stage stores and storehouse management and functional procedures in the depots has been revised.

AMMUNITION

22. **Definition**. Ammunition is defined as any munition of war whether defensive or offensive of any components whether filled or charged or intended to be filled or charged with explosive, smoke, chemical, or pyrotechnic compositions also:

a. Explosives made up of charges.

b. Explosives, Chemical charges and incendiary smoke or pyrotechnic material in bulk.

c. Non-explosives stores and components for use in the initiation or assembly of projectile explosive charges.

23. To take proper care of ammo and prevent deterioration, failure to function or even becoming dangerous to the users, Ammunition Technical Officer (ATO) and Ammunition Technician (AT) are on strength to give direction and guidance to unit on the maintenance and storage of the ammo on their charge. The guidance of an ATO will be sought on all occasions when difficulties are experienced while applying Ammo and Explosive Regulations or when any unusual problem arises in relation to storage, maintenance and movement of ammo.

SITING A BAD

24. The following are points to note when sitting an ideal ammunition depot:

a. **Accessibility**. An ammunition depot should be sited so that it can be easily accessible by road, rail and air.

b. **Isolation**. The depot should be sited at a reasonable distance from public buildings and residential areas. These are necessary to minimize the risks from fire and explosion

from outside sources.

c. **Concealment**. Trees and underground provide concealment to storehouses.

d. **Weather**. Areas which are subjected to storm and other atmospheric abnormalities are to be well drained and not liable to flooding.

f. **Extent of Areas.** The area must be large enough to allow future expansion and development.

ARMAMENT AND AMMUNITION DEPOT

25. Ammunition is one of the combat supplies managed by the NAOC. Types of ammunition use by the Army are:

a. Artillery, Mortar, Rockets and Small Arms Ammunition.

b. Mines and Grenades.

c. Pyrotechnics and Smoke Generators.

d. Demolition Explosives.

e. Missiles.

CARTRIDGES

26. Cartridges are bagged propellants, charges of separate loaded ammo. They are both illuminating and signal cartridges. The BL System Cartridge have the following characteristics:

a. Economical, cheap and easy to manufacture.

b. Do not leave live or empty cartridge cases requiring salvage.

c. Storage and transportation is easy.

d. Do not need extraction of cartridge case after firing.

e. In event of misfire, the removal and replacement of the tube alone is sufficient. This can be done without opening the breech.

CLASSIFICATION OF PREMATURE, GENERAL ACCIDENT, FAILURES AND DEFECTS

27. All incidences involving the malfunctioning, accidental functioning or misassemble of ammo and explosives will be classified as below:

a. **Premature**. Any round of guns, howitzer, mortar or similar ammo which on firing prematurely explodes or detonates will be classified as follow:

(1) **Bore Premature**. Any premature which occurs inside the bore of the wpn.

(2) **Muzzle Premature**. A premature which occurs in flight within 100 yards from the muzzle end.

(3) **Flight Premature**. A premature which occurs anywhere on trajectory between a point 100 yards from the muzzle or launcher and a point just short of the target.

b. **Failures**. Any round or component of ammo which fails to function as intended or expected e.g. misfires, blinds, excessive deviation in range or line are described as failures.

c. **Defects**. Defects are any fault in the constitution or marking of the ammo or the package not attributable to normal deterioration.

d. **General Accident**. General Accidents are any unusual or unexpected incidents not classified as premature, failures or defects e.g. a fire-involving explosion in an ammo depot, storehouse of the ammo, the accidental explosion of a round or component.

PROCEDURE FOR THE INSPECTION SENTENCING AND CLASSIFICATION OF AMMUNITION

28. All ammo holdings in the NA will be inspected periodically by ATOs and classified according to their physical conditions as follows:

a. Condition A – Ammo which is 100% fit for operational use.

b. Condition B – Ammo carrying restriction which requires modification before use in peace time but may be issued during a state of emergency.

c. Condition C1 – Ammo requiring 100% inspection, repairs/modification before issue in peacetime but which may be issued during a state of emergency without 100% inspection.

d. Condition C2 – Ammo requiring 100% inspection/repair/modification before use in any circumstance.

e. Condition D – Ammo for disposal.

f. Condition D1 – Ammo for break down.

g. Condition D2 – Ammo earmarked for possible sale

h. Condition D3 – Ammo earmarked for disposal.

INSPECTION AND SENTENCING OF AMMO

29. Both inspection and sentencing of ammo are governed by the physical condition of the ammo as well as the stipulated shelf – life of the complete system. The following inspections are normally carried out by ATOs.

a. **Initial Acceptance Inspection**. Initial acceptance inspection is carried out when ammo is to be received into the depot from factory.

b. **Routine Inspection**. Routine inspection is carried out in depots and units stock holding to ascertain the homogeneity of ammo and components after storage in varied climatic conditions or after the first quarter of its shelf life.

c. **Pre-issue Inspection**. Pre-issue inspection is carried out whenever ammo is to be issued to user units.

d. **Special Inspection**. Special inspection is carried out by the Director of Ammo as a result of a serious defects/incidents occurring with any ammo item. This inspection involves 100% examination of ammo and its associated components.

SENTENCING

30. Sentencing of ammo at routine inspection is dependent upon a service Quality Requirement which varies according to the role which the ammo will be called upon to fulfill. In these context therefore, ammo is divided into the following classes:

a. **Class 1**. Class 1 Ammo is designed for an intended use in an operational role together with component and ancillaries for use herewith.

b. **Class 11**. Class 11 Ammo is designed for use in an operational role but bearing an inherent and permanent restriction limiting its use to training or ammo solely designed for use in training or practice role and components/ancillaries having no operational role and use specifically as training or as practice ammo.

c. **Class 111**. Class III training expedients listed such as AFG 3412.

VEHICLES ISSUE PROCEDURE

31. The basic vehicle issue procedure ensures the following:

a. All vehicles issue are covered by authentic Release Order (RO) from competent staff authority.

b. Vehicles are selected for issue from stock on "First – in First out (FIFO) basis"

c. Vehicles are properly prepared for issue and leave the depot in good mechanical condition with complete repair kits

and tools.

d. Documentation should be simple and unit collection practice do not have to visit too many offices.

e. Proper accounts are maintained, receipts progressed and stock balance reported to enable release by staff.

f. Acknowledgement are received once vehicles are brought on charge by units and the Part X orders so published are received at the issuing depot.

32. The officer is required to be able to answer questions on vehicle issue in the depots and receipts in the user units

33. At this stage the officer is required to be able to know the components of ammo, siting a BAD, classification, inspection and sentencing of ammo.

TYPES OF VEHICLE

34. Officers should be able to identify and classify the various military vehicles in NA's inventory. This is to include the following:

a. A Vehicles – Armoured Vehicles.

b. B Vehicles – Soft Skin Vehicles.

c. C Vehicles – Earth Moving Vehicles.

d. D Vehicles – Amphibious Vehicles.

e. E Vehicles – Specialist/Modified Vehicles.

35. Officers should also be able to distinguish between Issue Order and Release Order as it affects vehicles. Issue Order is given at a higher level usually at AHQ, while Release Order is given by HQ NAOCS.

36. **Books/Materials for Further Reading**. Additional information are available in the following:

a. Comdts Technical Instruction.

b. Q Admin Instructions.

c. Ammunition and Explosives Regulations (Land Service).

d. Issue Order – based on AHQ.

e. Release Order – HQ NAOC.

IEDD RESPONSIBILITIES AND CATEGORIES

37. **Explosive Ordnance**. These are all munitions containing explosives, nuclear fission or fusion materials and biological and chemical agents. This includes bombs, warheads, SAA, mines, rockets and all similar or related items or components explosive in nature. Also includes clandestine and IEDs.

38. **Explosive Ordnance Disposal**. The detection, identification, evaluation, renders safe, recovery and final disposal of unexploded explosive ordnance. It may also include the render-safe and or disposal of such explosive ordnance which have become hazardous by damage or deterioration when the disposal of such explosive ordnance is beyond the capabilities of personnel normally assigned the responsibility for routine disposal. This effort may be subcategorized by the following types of ordnance:

a. Biological and Chemical ammunition.

b. Conventional ammunition

c. Improvised Explosive Devices.

d. Nuclear weapons.

e. Underwater ammunition.

39. **Improvised Explosive Device**. Those devices placed or fabricated in an improvised manner incorporating potentially destructive, damaging or lethal chemicals, designed to destroy, disfigure, distract or harass. They may incorporate military stores, but are normally devised from non-military components.

40. **Improvised Explosive Device Disposal**. This can be defined as the detection, identification, field evaluation, rendering safe, recovery and final disposal of IEDs.

RESPONSIBILITIES

41. The responsibility for IEDD is primarily discharged by the Ordnance Corps. In peacetime, this is carried out in support of the civil police under the terms of Military Aid to the Civil Power. The DOA issues co-ordinating instructions for the operational control of IED incidents. However, each Service is responsible for its own property, and has other skills useful in IEDD. The division of Land Service responsibilities between the Ordnance and Engrs Corps in addition to areas concerning the NN and NAF is shown in the table below:

TABLE 1: LAND SERVICE RESPONSIBILITIES FOR EOD

Serial	Situation	EOD Responsibility for Advice and Execution				Remarks
		IED	Area Clearance	Land Service Ammo	En Air Delivered Wpns	
(a)	(b)	(c)	(d)	(e)	(f)	
1.	Peace time	NAOC (1)	NAE	NAOC	NAE	
2.	Transition to War	NAOC (1) (2) (3)	NAE	NAOC	NAE	
3.	War	NAOC/NAE (4)	NAE	NAOC (4)	NAE (4)	

NOTES

(1) Except that the NN will clear IEDs on Naval property, below the high water mark, and in all inland navigable waters, and the NAF will normally clear IEDs on NAF controlled airfields, units and installations.

(2) If required NAE will support NAOC.

(3) Maintain parachute trained IED disposal team for rapid deployment to isolated locations, including ships at sea.

(4) Both the NAE and the NAOC have individuals and formed units available in peace and war. Contingency planning for operations or general war should include NAE and NAOC resources as appropriate to meet the foreseen type of device or operation. Where both agencies are represented in peace and always in war, EOD command and control should be joint, NAE and NAOC, exercised through a G3 (EOD) cell, the representative with the major involvement at that stage taking the lead.

EOD OPERATIONS CHAIN OF COMMAND

42. The normal military chain of command and responsibilities are to be followed where the following personnel listed are in theatre of EOD operations:

a. Commanding Officers of EOD Units.
b. Senior Ammunition Technical Officers.
c. Ammunition Technical Officers.
d. Senior Ammunition Technicians.

IEDD CONTROL

43. The responsibility for IEDD Control may fall within the overall EOD responsibility in certain theatres. In such theatres and under the direction of G3 Operations, EOD Control is to:

a. Operate an EOD Control centre and assign specific EOD missions based on the categories and priorities decided by EOD staff.

b. Allocate EOD personnel and equipment.

c. Provide operational and technical direction; and co-ordinate support eg air transport, military police, technical intelligence teams and engineer and decontamination equipment.

d. Evaluate the work load of EOD units and recommend the even distribution of personnel and equipment accordingly.

e. Conduct liaison with rear operations and damage control centres, and through them, with police forces and civil defence organizations.

f. Notify EOD units of movement of nuclear, biological or chemical explosive ordnance through their area.

RESPONSIBILITY OF IEDD TEAMS

44. IEDD teams are responsible for reconnaissance, field evaluation, identification, render safe, recovery and final disposal of suspected IEDs.

DUTIES OF AN IEDD OPERATOR

45. **Safety**. The operator must ensure the observance of all safety procedures for explosives and equipment used by himself and his team. Any conflict between safety and collection of evidence is to be resolved using the IEDD philosophy and principles. The preservation of evidence must be sacrificed if it conflicts with safety.

46. **Security**. The operator must ensure that SOPs which affect physical security are complied with.

47. **Assessment**. The operator should make an appreciation of the situation, observing local SOPs and considering the following points:

a. Aim.

b. Factors, including current threat assessment.
c. Deductions.
d. Courses open.
e. Outline plan.

48. The operator should review his outline plan whenever he receives new information. If necessary he must make a new appreciation. If he has any doubts about action to be taken during the operation, he should seek advice from his immediate technical superior before taking that action.

49. **Command and Control**. The operator must maintain command and control of the IEDD team throughout the incident. He must brief all relevant personnel, including the IEDD team, on the actions he is recommending and taking.

50. **Continuous Improvement and Liaison**. When not tasked, the IEDD operator is to:

a. Ensure his knowledge of procedures, IEDD methods and threat assessment remains current.

b. Inform his SATO of any significant new information on IEDs or IEDD tactics.

c. Maintain a close working relationship with commanding officers and Operations officers within his operational area and advise them on IEDD matters. d. Prepare and give lectures when tasked.

51. **Explosive Advice and Assistance to the Civil Authorities**. IEDD operators may have to help the civil authorities in clearing or making safe explosives. In these circumstances the operator's task is to clear the area and to preserve explosive items of evidence eg clearance of an area after an accidental explosion.

However, if the only option is destruction in situ then this must be taken at SATOs discretion.

EOD STAFF OFFICER RESPONSIBILITIES

52. **Advice to Commander**. The EOD staff officer is responsible for advice to the commander and staff on all EOD matters. This includes recommending the organization and deployment of EOD units and personnel and the formation, location and operation of EOD Control centres.

53. **Planning**. The EOD staff officer is responsible for advice on EOD planning, including the following:

a. The preparation and continuous review of EOD operational plans, standing orders and Standing Operating Procedures (SOPs).

b. The use and role of other arms and services in support of EOD units.

c. The initial deployment of EOD teams and EOD trained personnel.

d. The reinforcement of EOD personnel and equipment into the theatre of operations and their later deployment on operations, in conjunction with EOD control.

e. The inclusion of EOD matters in relevant orders and directives.

54. **Reconnaissance**. Together with the relevant unit commanders and staff branches, the EOD staff officer is responsible for advice on the number of unit personnel that are to be trained in Explosive Ordnance Reconnaissance (EOR).

55. **Reports**. The EOD staff officer is to ensure that EOD and EOR reports are screened for information of technical intelligence value. He

must ensure that EOD and EOR reports do not compromise working practices and RSPs. He must also ensure that they are promptly and reliably evaluated, and that the interchange of information between the EOD staff and other staffs and establishments is speedy and efficient.

CATEGORIES AND PRIORITIES OF EOD

56. **Categories of EOD Incidents**. EOD incidents, which include IEDD incidents, are categorized by command decisions dependent on the threat. Potential targets should be precategorized where possible as follows:

a. **Category A**. This is assigned to EOD incidents that constitute a grave and immediate threat to life. Category A incidents are to be given priority over all other incidents, and disposal operations are to be started immediately regardless of personal risk.

b. **Category B**. This is assigned to EOD incidents that constitute an indirect threat. Before beginning operations, a safe waiting period may be observed to reduce the hazard to EOD personnel.

c. **Category C**. This is assigned to EOD incidents that constitute little threat. These incidents will normally be dealt with by EOD personnel after Categories A and B incidents, as the situation permits, and with minimum hazard to personnel.

d. **Category D**. This is assigned to EOD incidents that constitute no threat at present.

57. **Priorities of EOD Incidents**. In some theatres, in periods of intense activity, EOD incidents may be allocated a priority by higher formation on the advice of EOD personnel. IED incidents are normally classified as Priority 1. Priorities which may be allocated to EOD

incidents are as follows:

a. **Priority 1**. Category A or B task. Teams are to go to the incident immediately at the fastest possible speed consistent with safety, using emergency blue lights and horns. Disregard for traffic regulations is at the discretion of the senior operator, who is liable to prosecution in the event of an accident.

b. **Priority 2**. Category B, C or D task. Teams are to go to the incident immediately. All traffic regulations and speed limits are to be observed. Emergency lights and horns may only be used when serious delays are met.

c. **Priority 3**. Category C or D task. The task is to be cleared within 24 hours of the receipt of the report. The operator may extend the period to 48 hours with the agreement of the police authority which reported the incident.

MILITARY TECHNOLOGY (SUPPLY AND TRANSPORT)

NIGERIAN ARMY CORPS OF SUPPLY AND TRANSPORT

INTRODUCTION

1. The Nigerian Army Corps of Supply and Transport (NACST) is one of the major Q services. The Commander of the Nigerian Army Corps of Supply and Transport (NACST) controls the Corps and is responsible to the Chief of Army Staff through the Chief of Logistics (Army) for the efficiency of the Services his Corps provides. He exercises these responsibilities from the Corps Headquarters in Bonny Camp Lagos and through the various Commander Divisional Supply and Transport (CDST) at divisional supply and transport level.

2. The main responsibilities of NACST are:

a. Transport support for all arms and services including:

(1) The organization and operation of road, rail and amphibious transport (other than first line transport) in a theater of operation.

(2) Certain functions in connection with air movement and air logistics support.

(3) The operation of ports and the MAINTENANCE of a force over beaches.

b. The supply of Petroleum Oil and Lubricants (POL) and rations, including water in conjunction with the NAE.

c. The distribution, forward of RPs, of Combat Supplies (C Sups) through DPs or, in some circumstances, direct to units.

d. The movement of materials and personnel throughout the lines of communication as directed by the staff.

e. The supply of industrial gases.

f. The training of catering officers and cooks.

g. Fire prevention and protection.

OPERATIONAL PROCEDURE OF NACST

3. **Brigade Supply and Transport Company**. Each brigade is allocated a ST battalion which includes 3 transport companies. A standard organization of a ST company is shown at Reference A. It should be noted that:

a. Each transport platoon of a company holds a total of 15 general load carrying vehicles of 5 ton capacity.

b. The C Sup platoon is responsible for the technical control of C Sups held by the company for accounting and detailed issue of stocks to units. It includes some NAOC personnel to handle and account for ammunition in war only.

c. The Coy HQ platoon includes a Light Aid Detachment (LAD).

4. **Divisional Supply and Transport.** Each division is allocated a ST brigade which includes the ST battalions allocated to each brigade. A standard organization is shown at Reference A. This is typical example of how the brick system has been used to meet the requirements of a division. It should be noted that:

a. The divisional transport brigade may not accompany the ST in war but its vehicles could be used to augment the ST battalion.

b. Headquarters battalion includes a driver training wing.

c. C Sups Coy provide C Sups platoon to each brigade ST company.

5. **Command ST Battalion.** The Command ST formally AHQ ST Bn holds a considerable number of vehicles in reserve for AHQ movement and support duties. This unit would provide the third line transport necessary to support a division on operations. Its organization is shown at Annex C.

6. **Petroleum Reserve Depot**. At present, stocks of POL for Army are held by the Army Petroleum Reserve Depots (APRD). The Army will have a total of 5 x APRDs, one located strategically and one in each divisional area. The APRD at Lagos may be designated CPRD. Although these units are located in divisional area and likely to provide some support for divisions in war, they are operationally controlled by AHQ but administered by the Divs. An org of typical APRD is shown at Annex D.

7. **Comd ST Tpt Bn.** The Sp Tpt Bn located in Lagos, is designed to provide the Army with port and maritime service and also air freight facilities. Railway operations of the unit has been removed in the new approved NACST org. the org of this bn is shown in Annex E.

COMMAND AND CONTROL

8. Brigade HQ. The NACST is not represented at brigade HQ by a separated officer on the staff. The brigade ST battalion commander in addition to commanding his unit also acts as the NACST representative. His duties are as follows:

a. Advice to the commander and brigade HQ staff on transport and air dispatch matters.

b. Coordination of NACST transport within the brigade area.

c. Liaison between the divisional ST battalion and brigade units.

d. Detailed sitting of NACST units in the brigade areas within general area allocated by the Q staff.

e. Coordination of programme (opening times etc) for DPs serving the brigade with the Q staff.

9. **Divisional HQ**. At each division, NACST is

represented by a Commander Divisional Supply and Transport (CDST) whose responsibilities, in addition to commanding the divisional ST battalions are:

a. Advice to the commander and divisional HQ staff on transport and air dispatch matters.

b. Supply of POL and rations in accordance with the Q staff plan.

c. Holding and distribution of C Sups in the divisional area in accordance with the Q staff plan.

d. Movement of other materials and troops lifting within the divisional area.

e. Detailed sitting of DPs in locations allocated by the Q staff.

10. **DPs**. CDST is responsible for establishing DPs in the divisional area for the issue of C Sups. A DP consists of a number of loaded NACST vehicles from which unit echelon vehicles draw their requirements to replace expended first line stocks. The detailed split of responsibility between the AQ staff and CDST is as follows:

a. AQ Staff. The responsibilities of the AQ staff is to decide the number of DPs necessary to support the formation depending on the extent to which units are dispersed and the tactical situation.

b. CDST. CDST is responsible for: (1) Implementing the Q staff's plan. (2) Reconnaissance of the site in detail. (3) Ground and air protection. (4) Traffic control. (5) The layout and operation of the DP.

11. **Replenishment Parks**. NACST is responsible for providing command and technical control elements for each RP. It is likely that CDST would draw the necessary NACST manpower from third line transport units and such units as Army Petroleum Reserve Depots (APRDs). In addition the Commander Divisional Ordinance Services

(CDOS) would provide some NAOC manpower probably from a base ammunition depot to handle and account for ammunition. The staff is responsible for providing labour and local protection. The OC of the command element is responsible for:

a. Layout of the site.
b. Defence, including concealment and camouflage.
c. Traffic circuits and traffic control.
d. Priorities of work.
e. Movement.
f. Liaison.

ORGANIZATION OF NACST AT ALL LEVELS

12. **Basic Organization**. An outline organization of the NACST is at Annex A. The majority of NACST units are organized on the 'brick' system meaning that, NACST sub-units allocated to lower formations are capable of executing the Corps' functions as their parent units but at lower scales. The NACST also provides standard establishments for company HQ and individual transport platoons irrespective of the unit role or equipment. A transport platoon normally consists of 15 task vehicles. NACST has now established tank transporter companies (coys) as the need for them today is quiet evident. This system is sufficiently flexible to allow NACST meet the varied commitment of any type of operation by building up units based on the standard transport platoon. The factors which should be taken into account are:

a. The seize of the force being supported.
b. Terrain.
c. The length and nature of the lines of communication.
d. The availability of allied logistic support, local resources and air transport.

13. **Categories of Road Transport**. Road transport operated

by NACST can be conveniently divided into 2 categories:

a. **General Transport**. General transport category is comprised of general load carrying vehicles (eg 1/4, 3/4, 3, 5 and 10 tonne cargo trucks).

b. **Special Purpose Transport**. The special purpose transport category covers standard load carrying vehicles with specialist bodies, (eg bulk fuel tankers) and specialist vehicles (eg tank transporter).

MECHANICAL TRANSPORT OPERATIONS

TYPES OF DRIVING

NIGHT DRIVING

INTRODUCTION

1. It is not very easy to drive at night but with constant practice one get used to it. At night your vision is less and so must be your speed. The driver should always drive at such a speed that will be able to stop within the distance illuminated by his headlights. Such distance must be calculated to include stopping and braking distance.

AIM

2. The aim of this chapter is to teach the student how to drive at night.

WHEN TO DIM

3. The head light should always be dimmed:
   a. When approaching oncoming vehicle. Cyclist or pedestrian.
   b. When following fairly closely behind another vehicle (to prevent dazzling the driver through his rear view mirror.
   c. When driving in well-lit built up area.
   d. Better vision headlight in fog or falling snow.

PREPARATION FOR NIGHT DRIVING

4. To prepare for night driving, observe the following:
   a. The wind screen wiper blade and driving mirror must be properly clean.
   b. All lights eg head lamp, trafficator light, brake light; packing light should be thoroughly cleaned and functional.

c. The driver should position himself properly and the steering wheel be held with the left hand between 9 and 10 o'clock. It should never be held by spokes. The thumb should be on the surface of the steering wheel and not round or hooked round the spoke. d. Good rest before the journey.

e. Ensure all accompanying tools for emergency are carried (to include spare tyres, torches, bty).

f. Ensure at least two crew members.

PRECAUTIONS DURING NIGHT DRIVING

5. The precautions to be taken during night driving are as indicated below:

a. Observe oncoming vehs, cyclist, pedestrian etc.

b. Use full light only when necessary.

c. Dim your lights for oncoming vehicles.

d. Maintain only appropriate maximum speed.

e. Avoid looking at the oncoming vehicles.

f. If you are dazzled by an oncoming vehicle head light, reduce your speed.

g. When approaching a road junction, cross road, round-about slow down properly.

h. Dim your lights to properly have a good view of bends a-head.

CROSS COUNTRY DRIVE

INTRODUCTION

1. Every military driver must be capable of driving cross-country. This aspect of driving is important because it gives the driver an opportunity to drive along all types of road conditions eg even road, hills narrow bridges, bad surface roads, etcdy and night.

AIM

2. The aim of this chapter is to teach the students on cross country drive.

EQUIPMENT FOR CROSS COUNTRY DRIVE

3. The following equipment are required for cross country drive.
   a. Digger.
   b. Shovel.
   c. Plank.
   d. Towbar chain or rope.
   e. Jerrican for water.
   f. fire extinguisher.
   g. Jack, wheel spanner, jack lever.
   h. Hoe.
   I. Cutlass.
   j. Tool box.
   k. Torch light.

THINGS TO DO BEFORE UNDERTAKING A CROSS COUNTRY DRIVE JOURNEY

4. The following are necessary:
   a. Know the route and the destination.
   b. Know the total number of km to be covered.

c. Know the condition of the vehicle.

d. Ensure there is spare tyre. Also check tyres gauge.

e. There must be work shop personnel to handle any mechanical or electrical.

f. There should be a second driver.

g. Ensure load and eqpt are secured.

h. Provision of escorts if necessary.

PRECAUTIONS FOR A CROSS COUNTRY DRIVING

5. The following precaution should be taken while on a cross country drive.

a. Watch out for bumps and ditches.

b. accelerate steadily where applicable.

c. Do not accelerate when the vehicle is skidding.

d. In case of skidding turn the steering against the skidding direction and put the veh back on track.

DUTIES OF MECHANICAL TRANSPORT OFFICER

INTRODUCTION

1. The unit MTO is responsible for ensuring that maximum number of unit drivers and vehicles are ready always to carry out any duties required of them. This requires high standard of maintenance, foresight in the provision of spares and liaison with the attached LAD or workshop. Careful coordination of all bids for transport to ensure its most economical use, the basic responsibilities of MTO are:

a. Signing and collection of issued vehicles on behalf of the unit.

b. Conduct of initial servicing.

c. Maintenance of vehicle documents.

d. Maintenance of vehicle states.

e. Maintenance of vehicle and related equipment serviceability in conjunction with LAD or workshop.

e. Vehicles and equipment security.

g. Vehicles allocation to drivers and platoon/ section.

h. Vehicles detailing in accordance with established procedures.

i. Accident procedure when required.

j. Continuous training of vehicles and equipment operators.

k. Command and administration of MT yard.

l. Unit maintenance through the echelon system in the field.

m. Development of movement details.

n. Adviser on movement and vehicles matters to the CO.

INTRODUCTION TO MT FORMS AND BOOKS

INTRODUCTION

1. Forms and books are important in keeping records of military vehicles and POL consumption some these forms will be introduced in this chapter.

AIM

2. The aim of this chapter is to introduce to the students the forms and books used in the Mechanical Transport (MT) office.

PURPOSE OF MT FORMS

3. The purpose of MT forms and books are to enhance smooth administration in the MT office and for proper vehicle accounting.

TYPES

4. Types of forms and books used in the MT office are as follows:
   a. AFG 3518 Transport Work ticket.
   b. AFG 810 – daily state and inspection chart.
   c. AFG 756 – Vehicle requisition form.
   d. AFG 1033 – Issue and receipt voucher.
   e. Gen 61A – Vehicle Serving card.
   f. Gen 62 – Vehicle History Book.
   g. AFG 3929 – part x order.
   h. AB 405c – Unit vehicle register.
   i. AFG 3652 – Convoy Note.
   j. AFG 1043/1045-Combined request and repair of equipment.
   k. AB 183 – Ledger for all purpose.
   l. FMT 3 (A) Traffic Accident report on disciplinary Action.
   m. FMT 3 (Rev) - Traffic Accident Report.

ORGANIZATION AND CONTROL OF CONVOY

6. **General**. The main aim of organization and control of convoy is to deliver load, equipment, troops when and where required with due regard to the economical working of the transport.

7. **Composition**.

a. **Head of Convoy**.
   (1) Element of Military Police for the convoy.
   (2) Close recce element (when necessary).
   (3) Packets.
   (4) Security elements.

b. **Main Body**.
   (1) Most of the packets.
   (2) Convoy comd.

c. **Main Convoy**.
   (1) The rest of convoy.
   (2) Medical.
   (3) Repair and convoy.
   (4) Catering.

d. **Other Elements**.
   (1) Despatch.
   (2) Repair and convoy.
   (3) Medical.
   (4) Catering staff.
   (5) Security.

8. **Methods**. There are three important methods of road movement. Those are as follows:

a. **Packet System**. When vehicles move in small groups of four to six with a considerable gap between the groups.

b. **Column System**. Vehicle driven in long column with even spacing Used when the column is moving at high

density. This presents the greatest control over movement and would be used in a division Corps area when there is no nuclear threat.

c. **Capacity Method**. When vehicles of one or more formations are simultaneously fed on to a route up to the maximum number which the road can handle without closing traffic. This leads to the maximum use at road.

RESPONSIBILITIES OF CONVOY STAFF

9. **Convoy Commander**. The convoy commander is responsible for the whole conduct of the convoy. He must ensure that all commander including the vehicle drivers are issued with a route card before the convoy starts. He should be free to move at will information regarding the convoy reaches him through dispatch riders and he gives his orders through them. He must ensure that good system of traffic control is in operation at all wayside halts and over the whole length of the control.

10. **Convoy 2IC**. In charge of tail column. The duties of the second in command in charge of the tail column will generally be the control, coordination and protection of the rear column.

11. **Officer – in – Charge Head of the Column**. The duties of the officer in charge of head of column are route finding and pace setting. His veh carries blue flag. The dispatch riders may come under his command. The officer-in charge head of column must control his speed most carefully at all times. Bearing constantly in mind the long column that is behind him. Upon the speed at which vehicles travel will depend to a great extent the amount of telescoping that goes on in the column. This, of course must be avoided. The leading vehicle must therefore:

a. Move off only at a very low speed from halts,

maintaining his low speed till it is considered that all vehicles are on the move.

b. Keep up a very even speed during running, only speeding slightly when approaching a hill and maintaining the increase speed until it is considered that the last vehicle is on the top of the hill.

c. Before halting, proceed at a reduced speed to allow vehicle behind to obtain their proper distances.

12. The Officer-in-Charge head of column is also known as a pace setter. He is usually an experienced officer, Junior Commissioned officer or non Commissioned officer in addition to the duties enumerated in above, he is responsible for the following:

a. Reconnaissance including check of diversions when an emergency the column is required to go around unexpected road blocks or traffic jams.

b. Posting of guide or route markers at inter sections and at other positions along the route where special directions to one column may be necessary.

c. Notification in traffic control and other authorities of the approaching the convoy to facilitate the clearing of the column.

d. close communication with the column commander to ensure function any unforeseen developments and to receive orders and instructions concerning the move.

13. **Vehicle Leader**. If a passenger is available beside the driver, such as a person should assume the duties of the vehicle leader. He is responsible for assistant the driver as far as possible by route finding, traffic control at halts, spotting of hostile an craft observation of visual signaling and maintenance of current vehicle density.

14. **Dispatch Rider**. The duties of dispatch rider are:

a. Reconnaissance.

b. Route Marking.

c. Inter communication.

d. Maintenance of speed of vehicle as ordered.

f. Traffic Control.

g. Shepherding of beak-down. 15. Every column should, whenever possible, be preceded by one or preferably two motorcycle outriders, moving within visual distance of each other and of the loading vehicles. They will collect early information of any obstructions, progress of the column and repot these to the column commander.

16. There is no hard and fast rule on the use of motorcycle in convoy running or in positioning the motorcycle in convoy. In positioning the motorcycle the following points should, however, be borne in mind:

a. The necessity for having two cut riders in front of the column.

b. The necessity for placing motorcycle between the submit to function as connecting links.

c. Motorcycle should also be positioned evenly along the column exercise control over the convoy running.

d. It may not be possible to use motorcycle in column must country.

17. The quick and easy maneuverability of a motorcycle make it an ideal means of intercommunication in convoy running.

18. **Officer–in-Charge Tail Column**. The duties of the Officer–in-charge tail of column are to check all causalities and to report them to column commander by means of the first available

dispatch riders. Is vehicle carrying a green flag. He should have under command one vehicle carrying the vehicle mechanic and the electrical whose task is to effect repairs and to assist the officer-in-charge tail of column to assess the length of time the vehicle will be off road if for any rising the broking down vehicles have to be left behind, there must be two drivers per vehicle and arrangement made or the recovery of the vehicle and the men at the earliest.

19. In addition to the above duties, the officer–in-charge tail of column is responsible for.

a. Reporting at every halt or stated intervals regarding causalities.

b. Reporting the location of tail of column when required.

c. Preventing vehicle or other traffic which might interfere with the move from entering or passing the column from the rear. This does not apply to vehicle which has authority to overtake convoy.

d. Posting necessary guide at the tail of the column to wart halts approaching from the rear when the column halts.

e. Picking up and as soon as practical returning to the head of the column off guides and markers distributed by the head of the column.

f. Observing vehicles ahead for excessive telescopic action, bad march discipline and on and taking necessary correction action.

g. Rendering first and to the injured in the event of accident and preparing accident reports.

CONDUCT OF CONVOY OPERATION

20. **Planning and Preparation**.

a. Staff checks (ascertaining the number of vehicle and troops to be moved).

b. Vehicle out sourcing (if necessary).
c. Map/route recce.
d. Convoy/operation orders.
e. Vehicle preparation eg servicing, checking of fire extinguisher FAMTO etc
f. March discipline.
g. Sound administrative Arrangement.

21. Accident procedures.

22. Convoy Commander Check List:
a. Rules of the road.
b. Traffic Laws and regulations.
c. Speed Limit.
d. Time and distance gaps.
e. Routing plans.
f. Schedules.
g. March discipline.
h. Flag off of convoy.

23. Convoy Security Measures:
a. Progress report.
b. Ambushing and debussing drills.
c. Vehicle marking.
(1) Leading vehicle – Blue flag by day blue light at night.
(2) Last vehicle - Green flag by day and green light by night.
(3) All vehicles- Yellow flag by day and yellow light by night
d. Communication.
e. Defense of convoy.

f. Maintenance of front, flank and rear security.
g. Security measures during halts.
h. An cover (as required).
i. Request fire support (as required).
j. March discipline.
k. Maintenance of convoy Communication.

TRAFFIC ACCIDENT PROCEDURE

INTRODUCTION

1. Traffic accident may occur as a result of mechanical, circumstantial and psychological factors. These accidents can be prevented by the driver. However should an accident occur, a driver is expected to carry out certain procedure. These are known as traffic accident procedures.

ACTIONS TO BE TAKEN AT THE SCENE OF AN ACCIDENT

2. The necessary actions a driver needs to take at the scene of an accident listed below:

a. Stop the vehicle and switch off the engine, but do not move the vehicle if the accident is fatal or serious until the civil police arrive and permit you to do so.

b. Attend to any injured by giving necessary first aid and if the injury is serious get an ambulance or any other veh to take the injures person(s) to the nearest hospital. Whilst giving first aid, do not carry the injured about, etc. ensure the injured do not take any drink, not even water.

c. Take necessary fire precautions.

d. Control all traffic.

e. Contact, the civil police and military police.

f. Contact the fire brigade and get an ambulance if necessary.

g. Get reliable witnesses, not hostile people.

h. Give copies of FMT3 (R) to the civil police and any other party(s) involved in the accident.

3. Some important points to note when involved in an accident are as follows:

a. Do not admit liability.

b. Avoid argument.

c. Ensure a proper sketch of the accident scene is made by the civil and or military police.

d. Endeavor to make a sketch by yourself on the reverse side of FMT3 (R) especially if you must move your vehicle before the civil or military police arrives.

ACTION BY THE UNIT

5. On return to the unit the driver will report the accident immediately and the unit will take the following action.

a. Send a signal to the higher Headquarters reporting the accident within 24 hours of occurrence. b. Prepare and obtain the following:

(1) Four copies of FMT (R) ACCIDENT REPORT FORM.

(2) Four copies of typed and signed drivers statement and four copies each of any of the witnesses statement.

(3) Open up a file for that particular accident.

(4) Write for police report (Form B13) if the accident involves civil interest.

(5) Obtain NMD – Neglect misuse and damage report if the vehicle is sent to workshop.

(6) Forward all initial document to the higher formation Headquarters. These documents include:

(a) Original copy of FMT 3(R)

(b) Original copy of driver's statement.

(c) Original copy or copies of witness/witnesses statement.

(7) Prepare four copies of FMT 3A (disciplinary

action report Form)

(8) Complete NA Form 252 (charge sheet) and keep in file.

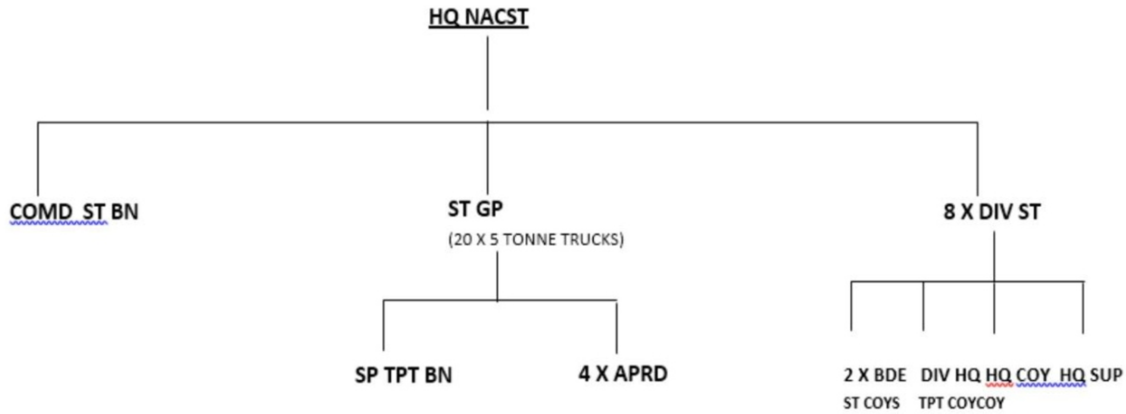
6. Once Police report – form B13, and the sketches are received from the civil police where civil interest is involved and the NM & d report is received from workshops, the case is ready for trial unless where the case is charged to count in which case the court proceeding and findings must be waited for.

Annexes:

A. Outline Org of NACST.
B. Org of a Mech Div HQ Tpt Coy.
C. Org of Comd ST Bn.
D. Org of Army Petroleum Reserve Depot.
E. Org of Support Transport Battalion.

ANNEX A TO
NACST /G1/300/7

OUTLINE ORG OF NACST

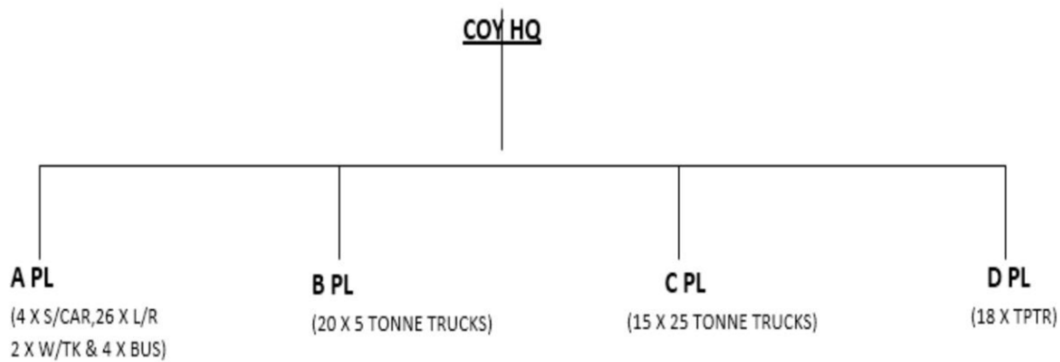


NOTES:

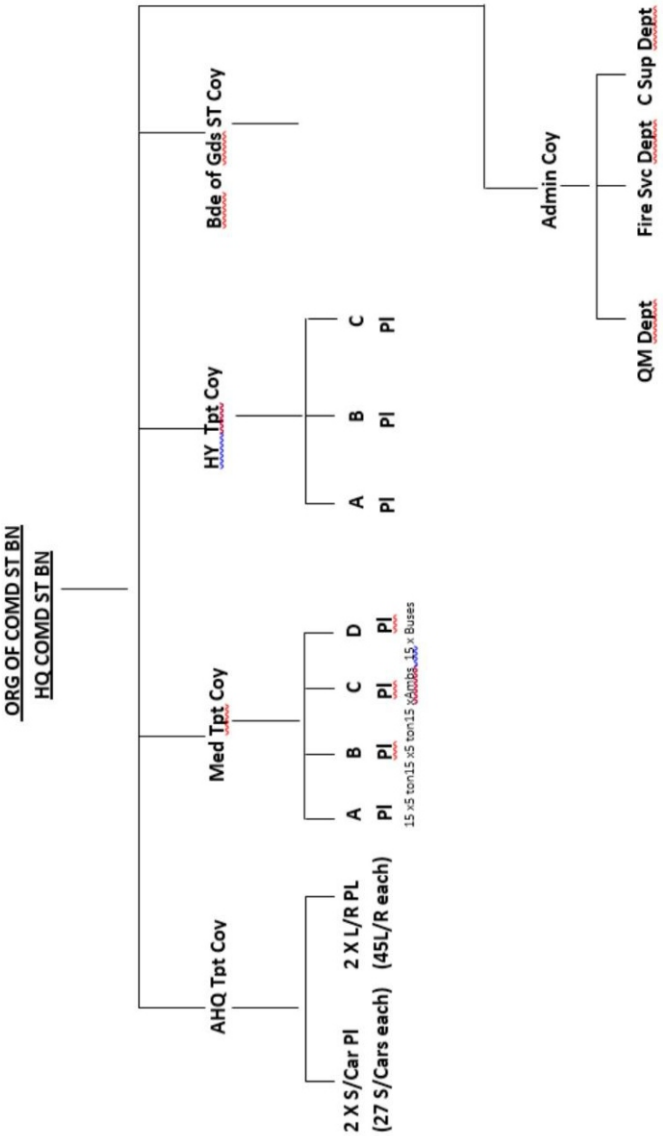
1. All DivsSts will have 1 x TkTptr Pl at the Div HQ Coy except 3Armed Div with two pls.
2. All Armed bdes have 1 x TkTptr Pl in addition to their normal 'B' veh holding
3. NACA Sp Arty Bde has 1 x Tptr Pl with HQ 3 Armed Div ST

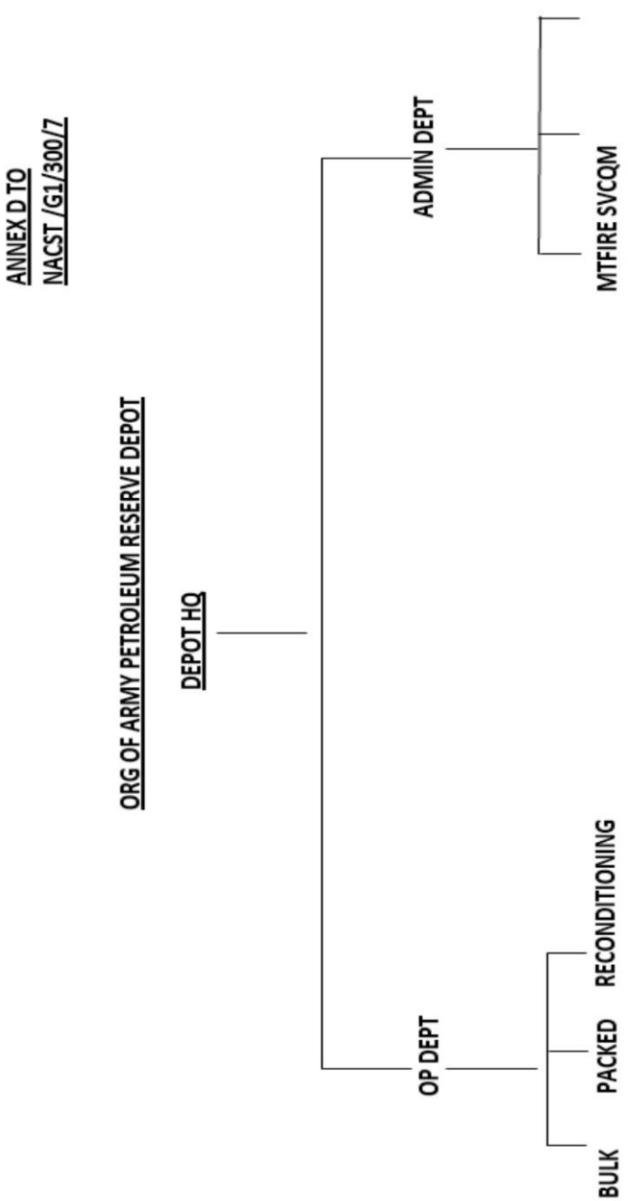
ANNEX B TO
NACST /G1/300/7

ORG OF A MECH DIV HQ TPT COY

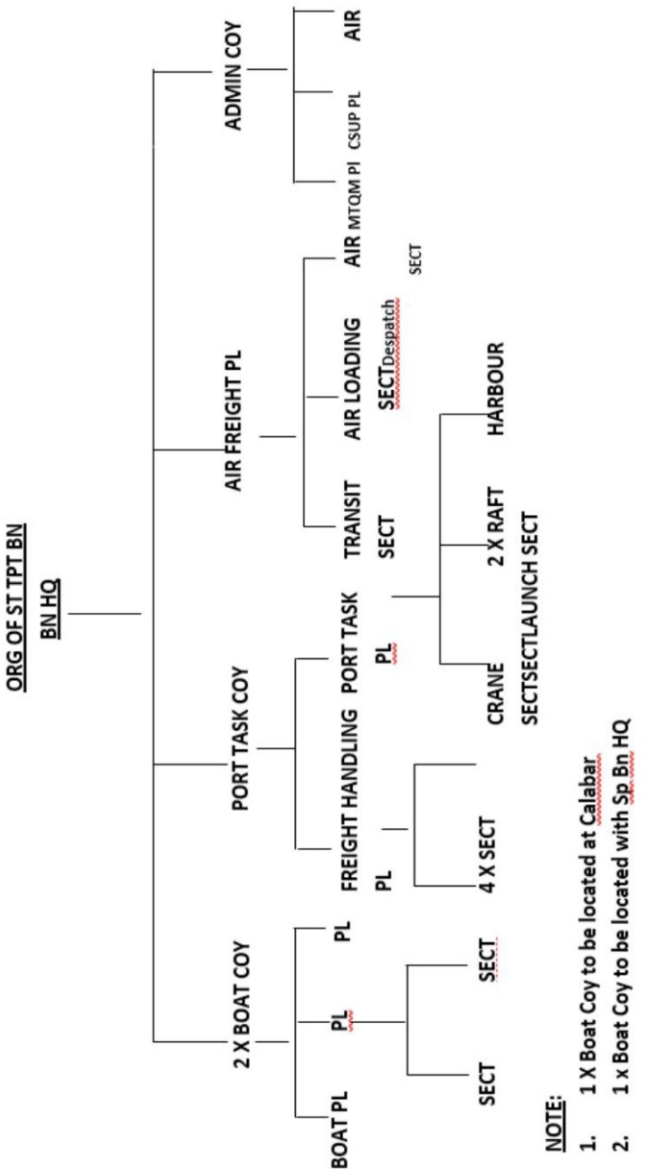


ANNEX C TO
NACST /G1/300/7





ANNEX E TO
NACST /G1/300/7



NOTE:

1. 1 X Boat Coy to be located at Calabar
2. 1 x Boat Coy to be located with Sp Bn HQ

MILITARY TECHNOLOGY (ELECTRICAL AND MECHANICAL ENGRS)

NIGERIAN ARMY CORPS OF ELECTRICAL AND MECHANICAL ENGINEERS

INTRODUCTION

1. Military technology has assumed an unprecedented advancement globally in recent times. Thus, for an army to remain relevant, it is expedient for her crop of officers to be abreast with these modern trends. One of the ways the Nigerian Army (NA) has devised to prepare her middle level officers for future challenges is the Captain to Major Written Promotion Examination (CMWPE). However, in line with the dynamism of military technology, it has become expedient for the syllabus and module for this subject to be reviewed. Hitherto, the Military Technology module for Nigerian Army Electrical and Mechanical Engineers officer was vague with only topics listed. The module did not include the extent student officers are to read nor give direction to the precise document they are to use for the examination. This has made it difficult for both the students and the examiners alike as the scope was not defined. Thus, the need to review this module to make it more realistic and relevant.

AIM

2. The purpose of this module is to give guidelines to NAEME officers preparing for Military Technology paper in CMWPE.

GUIDELINES FOR CANDIDATES

3. The content of this module is to give guidelines to all NAEME officers seating for the SSCQE military technology paper. Efforts have been made to be as explicit as possible as regards areas where they would be tested. However, candidates are advice to keep themselves abreast with minor technical problems encountered during repair and maintenance of vehicles including general and basic engineering

principles such as types and cycles of operation in engines, structures and sub-assemblies of automobiles, drive train systems amongst others.

NAEMES RESPONSIBILITIES

4. The NA has vested on NAEME Corps, the statutory responsibility of maintaining its electrical, mechanical, electronics, weapon, optical and electro-medical equipment. NAEMES is also to provide technical advice on EME matters to commanders at all levels. To this end, NAEME roles are as highlighted below:

a. Pre-procurement test and trial to determine the suitability of equipment to be introduced into service.

b. Pre-inspection of equipment to certify their conformity with laid down standard and adherence to technical aspects of the procurement contract. c. Modification of equipment.

b. Pre-inspection of equipment to certify their conformity with laid down standard and adherence to technical aspects of the procurement contract.

c. Modification of equipment.

d. Repairs of unserviceable equipment.

e. Recovery of equipment casualty.

f. Inspection of equipment to ascertain their serviceability or otherwise.

g. Scaling for spare parts requirement.

h. Formulation of electrical and mechanical engineering regulations (EMERs).

I. Training of NAEME Corps officers and soldiers.

j. Research and Development for the improvement of NA systems/sub systems and to keep abreast with developments in military science and technology.

CATEGORY OF EQUIPMENT TO BE MAINTAINED BY NAEME

5. The following equipment are to be maintained by the NAEME Corps.

a. Vehicles (A, B and C) including motorcycle.

b. Weapons (small arms, guns, mortars etc).

c. Electronics equipment.

d. Radar and gun control equipment.

e. Electrical equipment (Refrigeration, Air conditioner etc).

f. Office equipment (computers, photocopiers etc).

g. Electro-medical equipment.

h. Workshop equipment and plants including generators.

i. River craft and Aircraft.

ECHELON OF REPAIR/MAINTENANCE SYSTEM

6. The following are the levels are the levels of repairs in the NA:

a.. First line repairs/maintenance - Unit level (LAD).

b. Second line - Field workshop level (Bde or Div Wksps).

c. Third line - Base workshop level.

b. Fourth line - Central workshop level (Refurbishing/rebuilding).

TYPES OF MAINTENANCE - INSPECTION

7. NAEMES carries out the following inspections:

a. **Receipt Inspection**. This is carried out in NAOC Depot when equipment is being received from a contractor/vendor. Inspectors from Technical Group EME, NAOC personnel, the user unit and the vendor representative are involved in this inspection. This type of inspection is usually

carried out on new equipment just procured or acquired. The essence of this inspection is to ensure that equipment supplied are in accordance with the required/specified specifications.

b. **Issue Inspection**. Issue inspection is carried out in NAOC Depot when equipment is to be issued to the user unit. In addition to NAEME personnel, NAOC personnel and the user are also involved. Issue inspection is necessary to confirm the serviceability of an equipment before it is issued to the user unit. This form of inspection assists in eradicating arguments as to whether the equipment was serviceable before collection or not.

c. **Transfer Inspection**. Transfer inspection is carried out when a unit is being disbanded or has to transfer its surplus equipment to another unit. Representatives of the loosing and receiving units are involved with the NAEMES inspectors.

d. **Standard Inspection of Mechanical Transport and Technical Equipment**. Standard Inspection of Mechanical Transport and Technical Equipment (SIMTTE) is to be conducted annually by Tech Gp EME to ascertain the battle worthiness and availability of NA equipment. SIMTTE is a very important exercise as it helps determine the true state of all equipment in the NA holding. The outcome of a SIMTTE exercise is usually expressed in percentages.

CLASSIFICATION OF EQUIPMENT

8. Equipment are classified in NAEME based on the degree of repair work that has to be carried out. Repairs of NA equipment are classified as follows:

a. O - Observation.
b. S - Serviceable.
c. X - Unit repairs.
d. Y - Field repairs.
e. Z - Base repairs.
f. ZF - Central Workshop repairs (Refurbishment).

9. Equipment are further classified depending on the age of the vehicle or number of mileage covered as follows:

a. **Class I**. This is for a vehicle that is below 3 years in service or below 16,000 km for petrol engine or 32,000km for diesel engine and requires no Z job.

b. **Class II**. This is for a vehicle up to 3 years in service or up to 16,000km for petrol engine or 32,000km for diesel engine and requires no Z job.

c. **Class III**. This is for a vehicle below 3 years in service or below 16,000km or 64,000km for petrol and diesel engine respectively, but requires a Z job.

d. **Class IV**. This is for a vehicle up to 3 years in service or up to 16,000km or 64,000km for petrol and diesel engine respectively and requires a Z job.

e. **Class V**. This is a vehicle in the age or mileage category of class III or IV but requires base repairs or BLR or the repairs considered to last for more than 3 months from the date of entering the workshop.

f. **Class VI**. This is a vehicle that is Beyond Economic Repairs (BER) which may arise from damages to the chassis, cabs, bodies and major assy of the vehicle.

NAEME SUPPORT STRUCTURE IN PEACE AND WAR

10. **NAEMES Support in Peace**. In peacetime NAEME is organized in such a way that its sub-units, units and formations give the necessary support to different levels of command in the NA. The various activities that take place at the different levels of command are similar, difference only being in the number of personnel available at each level and the type of equipment in their inventory. These factors consequently dictate the types of repair they can undertake. Below are the various levels of support:

a. **Light Aid Detachment.** Light Aid Detachment (LAD) is the smallest repair outfit in the NAEME Corps which is usually attached to units, headquarters and training institutions and constitute the first line of repairs. It is usually commanded by a subaltern as OC LAD and it is expected to carry out unit repairs/first line repairs. The repairs carried out at this level are restricted to replacements of minor parts, assemblies and adjustments.

b. **Brigade and Division Workshop.** These constitute the second line of NAEME support at this level; repairs that are beyond the capability of an LAD as laid down in EMERs are carried out. Repairs at this level mainly comprise replacements of defective major assemblies, in addition to certain degree of repairs to major assemblies.

c. **Base Workshop**. This is the third line of NAEME support and is expected to generate major assemblies for repair of NA equipment. Majority of the work force in a Base Workshop are civilians because this outfit is usually located in the DSG (Divisional Support Group), which is well out of the forward lines. Other activities carried out at this level of repair

include complete overhauling and rebuild of equipment.

d. **Central Workshop**. Central workshop is the fourth and the highest level of repairs in the NA. It is expected to refurbish backloaded equipment casualties and also carry out some manufacturing or fabrication activities. It is worthy of note that this outfit is yet to be functional.

e. **Technical Group**. This is the think-tank of the NAEME Corps where forecasting, test and trial, modification, Research and Development (R&D) are to take place to mention just a few. Manuals on repair procedures are also produced by the Tech Group in order to standardize repair procedures. Additionally, routine inspection is also conducted by this Group to determine the battle readiness of the NA. The SIMTTE inspection is also carried out by this branch of EME.

11. **NAEME Support in War**. NAEME wartime support involves the following:

a. Ensuring the battle worthiness of the equipment to be committed into an operation at the preparatory stage.

b. At the execution stages, it involves:

(1) Keeping the Main Supply Route (MSR) clear of equipment casualties.

(2) Recovery of equipment casualties.

(3) Ensuring minimum equipment downtime.

(4) Ensuring that equipment that cannot be readily backloaded are rendered useless to the enemy at the withdrawal stage.

12. **NAEME Combat Grouping**. NAEME Combat Grouping is as

follows:

a. **LAD**. The LADs are grouped into the A echelon to provide the immediate technical support to the fighting units. It is organic to the unit it supports and moves with it in all phases of war.

b. **Forward Repair Group**. Forward Repair Group (FRG) is a detachment of a brigade workshop repair elements and it consists of Forward Repair Teams (FRTs) which are used to carry out speedy repairs of equipment casualties as far forward as possible. FRTs are usually on wheels and consist of 3 - 4 men armed with the replacement parts for the defective equipment.

c. **Main Repair Group.** Main Repair Group (MRG) consists of the entire brigade workshop less the FRG. It carries out repairs on jobs that require more time and workshop facilities to complete. The MRG is located in the BSG/DSG.

WORKSHOP PROCEDURE

13. A detailed workshop procedure in peacetime will be discussed below; but it should be bore in mind that the same procedure is applicable in war time. Another point of note is that the same procedure is applicable for all equipment and as such that of a vehicle would be used as an example as follows:

a. During peacetime a vehicle or equipment is received in the workshop with 5 copies of AFG 1045/1043 at the R & I section (forms not applicable in war time).

b. For repairable vehicles/equipment the 1043 portion of the form is cancelled leaving the 1045, if otherwise the 1045 is cancelled and the vehicle is sentenced appropriately (not applicable in war time).

c. In the case of repairable vehicle the owner of the vehicle is given a copy of the AFG 1045 with the loose items in the vehicle documented at the back of the AFG 1045 (examples of loose items include; Jack, spare tyre, wheel spanner and so on). The R & I section keeps a copy and forwards a copy to the production officer while the remaining 2 copies are sent to the IN inspection section with the vehicle. In war time all equipment are received in the R&I section for repairs, equipment not repairable are back loaded to the next higher formation.

d. The inspection department will raise 2 copies of AFG 932 (in case of vehicle) and also a copy of AFG 1084 (job card) specifying the various jobs required to be carried out on the equipment. AFG 1084 large shall be used for vehicle while AFG 1084 small shall be used for other equipment. Where defect is due to be an accident, the job card shall be written in Red ink. On completion of the IN inspection, the equipment will be forwarded to the Progress and Planning department with the following docus for registration and further action:

(1) AFG 1045/43 - 2 copies.
(2) AFG 932 - Original copy.
(3) AFG 1084 (duly completed).
(4) NM&D Report - In case of accident or Neglect.

e. The equipment is then forwarded to the relevant repair section for the repairs to be effected. At the various repair sections, spare parts required are collected from the ordnance store section using the form AFG 1033 (issue and receipt voucher). When items required for repairs are not available locally within the workshop, then form P 1922 (Contractors Bill) is used to source for the item through a contractor in return for cash. The list of repairs carried out and modification including the spare parts used on the

vehicle are entered into the vehicle History Book at the end of the repairs.

f. After the vehicle is duly repaired, it is sent to the inspection section for OUT inspection. The vehicle is sent back to the repair section to carry out any fault not yet rectified. If there is no fault then the vehicle is passed onto the R & I section where all the loose items taken from the vehicle on receipt are replaced and the PO is notified that the vehicle is ready for collection.

g. The PO sends out a call out notice to the vehicle owner unit to come for collection (this is usually in form of a signal). On arrival of the owner unit personnel in the workshop, the vehicle is checked to ensure that all the complaints are properly repaired and that all the loose items in the vehicle when it was brought to the workshop are in place.

h. After the vehicle is certified to leave the workshop, a gate pass (Form AFG 850) is filled for the owner unit personnel to enable him take the vehicle out of the workshop.

NEGLECT MIS-USE AND DAMAGE REPORT

14. Whenever it is detected that damage to NA equipment being inspected is occasioned by carelessness, neglect or misuse by the owner unit, the inspection section shall in addition to normal report, initiate a Neglect Mis-Use and Damage Report (NM&D) report on the equipment. The NM&D report brings out the cost of damage to the vehicle and also estimate the labour cost required to effect necessary repairs. The cause of damage is clearly stated in the report with necessary supporting remarks. The NM&D report is used when taking disciplinary action against the offender. It assists in issuing the appropriate punishment, especially when the offender needs to be

cashiered.

15. There are certain conditions that must be met before equipment considered NM&D is repaired. Where it is discovered that an equipment is damaged in the unit, the OC of the unit would be responsible for ensuring that the equipment is forwarded to the appropriate workshop for repairs and NM&D report raised accordingly. The workshop will not repair or evacuate equipment that is damaged as a result of neglect without ascertaining that the equipment is not required for a BOI or Court martial. If an acknowledgement is however not received within 14 days from the date of the NM&D report, repair works can commence on the equipment.

16. **Distribution of NM&D Report**. When there is need to raise an NM&D report, 8 copies of the NM&D report are produced and distributed as follows:

a.	Owner unit	-	1 copy.
b.	AHQ DOAL	-	1 copy.
c.	HQ NAOC	-	1 copy.
d.	HQ NAEME	-	1 copy.
e.	CVD	-	1 copy.
f.	HQ Div/Bde of owner unit	-	1 copy.
g.	Tech Gp EME	-	1 copy.
h.	File	-	1 copy.

MATERIALS MANAGEMENT

INTRODUCTION

17. One of the basic functions of management is to employ capital efficiently so as to yield maximum results. This can be done in either of the following two ways or by both:

a. By maximizing the margin of profit.
b. By maximizing production with given amount of capital.

This means that management should try to make its capital work as hard as possible. However, this is all too often forgotten and much time and ingenuity are devoted to make only labour work harder. In the process, the capital turnover and hence the productivity of capital is often neglected. Several new techniques have been developed and employed by modern managers to remedy this deficiency. Among these, Materials Management has become one of the most effective. Materials Management is a body of knowledge which helps the manager to improve productivity of capital by reducing material costs, preventing large amounts of capital being locked up for long periods, and improving the capital turnover ratio.

18. To understand the scope of materials management, consider an example of an engineering product such as a Toyota Hilux Super Structure. About 10 different kinds of raw materials (each with its own specifications, price ranges, storage life and different degrees of availability etc) probably go into the making of this super structure. The purchase, procurement and storage of this raw material is a part of materials management. The quantities to be purchased, identification of sources of good quality and regular supply, receipt

inspection, store accounting and issues, form the first stage of materials management. After this, the various raw materials enter the production process and eventually get converted into the end product. In the intermediate stages there might be scrap or other losses, retrieval, rectification and of course several inspections. The material undergoes these various processes including waiting. This is called workin-process. In the last stage, the completed product is mounted on the vehicle. The transportation, materials handling, disposal of scrap are all elements of materials management. The development of ground rules for ordering, issuing and reviewing materials stocks in order to obtain best value out of materials using scientific techniques is called Inventory Control. Inventory control can be classified and achieved using any of the following methods; ABC, VED and FNS classification. Only the ABC would be expatiated on in this module.

ABC ANALYSIS

19. ABC Analysis has gained prominence in connection with inventory control. For the purpose of inventory control of regular stock items (spare parts), it has now become customary in the industrially advanced countries to divide the regular stock items into A - High annual consumption value items, B - Medium consumption value items and C - Low annual consumption value items. After this classification, different procedures and routine are applied to the three different classes of stores. The basic idea is to give maximum attention and time to "A" items, a fair amount to "B" items and simplify the procedures so as to require minimum time for dealing with "C" items. The general principles of ABC Analysis can be extended to almost every type of activity. In NAEME it is a very important tool in the purchase and request for spare parts.

20. As a matter of principle and by default, a larger percentage of the investment for inventory is concentrated on relatively few high-value items. The procedure for classifying inventory using ABC analysis is as follows:

a. Estimate the average yearly usage for each item in inventory.

b. Multiply average yearly usage for each inventory item by unit cost to determine the value of usage.

c. List inventory items in descending order of usage value.

d. Compute the cumulative consumption figure values as per order of listing of inventory items.

e. Convert the cumulative consumption figure values into percentage of the cumulative total.

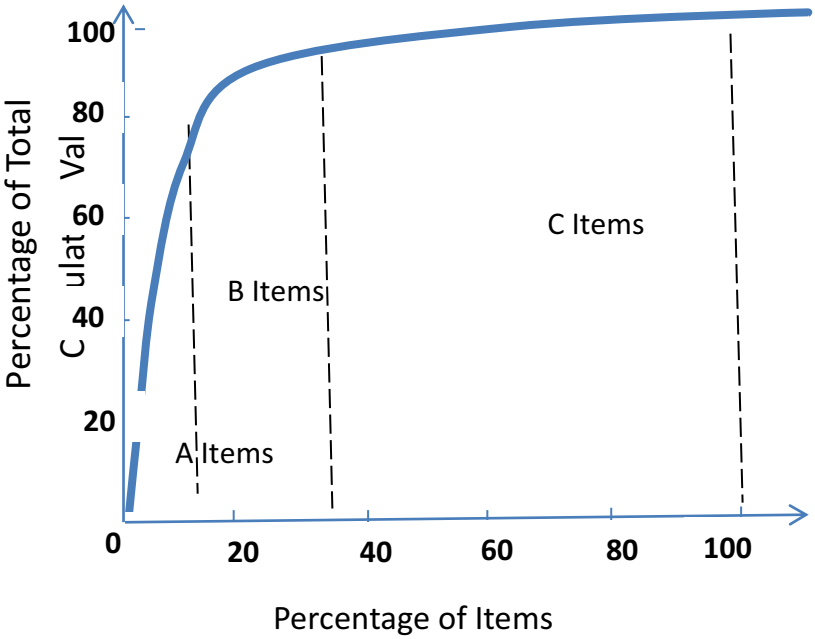
f. Compute the percentage no. of items contributing the percentage of cumulative total.

21. The following format may be used for this purpose.

Item No	Nomenclature	Unit Cost	Qty	Total Cost	Cumulative Cost	% Cumulative Total	% No of Item

A graph is then plotted with percentage of items on the 'X' axis and percentages of cumulative total cost (percentage of value) on the 'Y' axis as shown in the figure below. On the average the following relationship could be established.

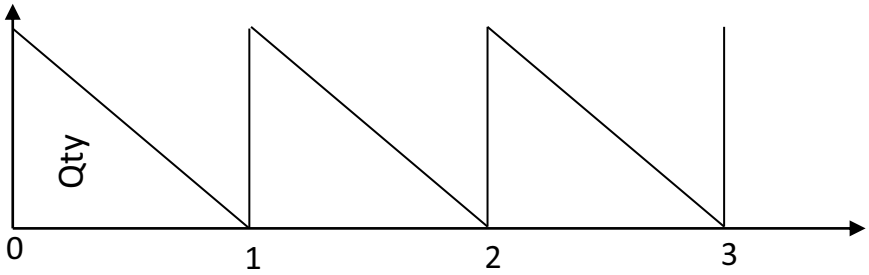
Category	% of Items	% of Value
A	10	70
B	20	20
C	70	10



22. Ten percent of the items contribute to about 70% of the total cost of inventory and they are called 'A' items. 20% of the items contribute to 20% of the total cost and are called 'B' items. The remaining 70% of items contribute only 10% of the total cost and they are called 'C' items.

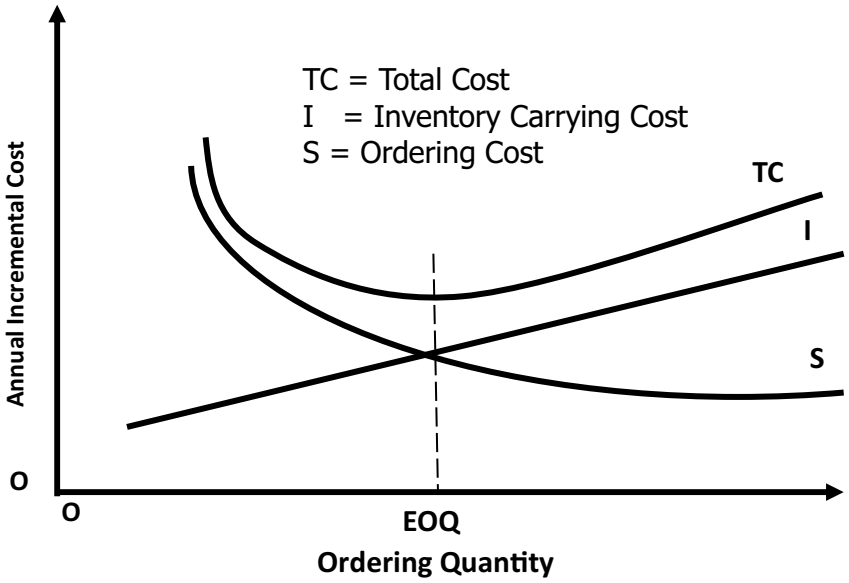
ECONOMIC ORDER QUANTITY

23. Economic Order Quantity is another inventory control method ensuring stocks or spare parts are not ordered above what is needed. It will be seen from the figure below that 'Q' is the working stock which is the quantity ordered at predetermined intervals. When the quantity 'Q' arrives the inventory is maximum and it is gradually consumed till it reaches the minimum of zero when the fresh stock of 'Q' arrives. The inventory thus carried, therefore, varies from 'Q' to zero. This means the average inventory carried is Q/2.



Time (in Months)
Ideal Inventory Model

22. **EOQ Formula**. The inventory carrying cost is made up of several costs which have to be incurred if an inventory has to be carried. This increases with increasing quantity and is represented by the hyperbolic curve 'S'. The quantity for which the two costs are equal, therefore, represents the minimum total inventory cost.



22. For example, let 'A' be the annual consumption of an item in Naira 'S' the ordering cost per order and 'I' the inventory carrying cost expressed as a percentage of the inventory cost. If 'Q' expressed in Naira represents the minimum quantity to be ordered at a time or the minimum inventory cost the average inventory carried is Q/2 Naira.

$$\text{Inventory Carrying Cost} = \frac{Q}{2} \times I \text{ Naira per annum}$$

$$\text{No of orders per year} = \frac{A}{Q}$$

$$\text{Ordering Cost} = \frac{A}{Q} \times S \text{ Naira per annum.}$$

For the minimum cost inventory these two costs are equal as seen in the figure above:

$$\frac{QI}{2} = \frac{AS}{Q}$$

$$Q = \sqrt{\frac{2AS}{I}}$$

The formula above expresses Q and A in Naira. Since $\sqrt{\frac{2S}{I}}$ for any organization is constant,

$$Q = K\sqrt{A,} \qquad \text{Where } K = \sqrt{\frac{2S}{I}}$$

26. This square root relationship is not generally known and this is one reason why excess inventories are carried in many undertakings. When sales increase, the production must naturally be raised proportionately, but it is not necessary to increase the inventories in the same proportion. To ensure regular and continuous flow of materials, inventories of any particular item of production need increase only proportional to the square root of the respective higher annual requirement of the items.

PRACTICE QUESTION

27. A company uses 50,000 widgets per annum which are N10 each to purchase. The ordering and handling costs are N150 per order and carrying costs are 15% of purchase price per annum, i.e.(it costs N 1.50 p.a. to carry a widget in stock N10 x 15%). Where:

Total Costs p.a. = Ordering Cost p.a. + Carrying Cost p.a.

Where:

$$\text{Ordering cost p.a.} = \text{No. of orders} \times ₦150$$

$$\text{No. of orders} = \frac{\text{Annual Demand}}{\text{Order Quantity}}$$

For example, if the order quantity was 5,000 widgets,

$$\text{No. of orders} = \frac{50{,}000}{5{,}000} = 10$$

Ordering cost p.a. = 10 x ₦150 = ₦1,500
And
Carrying cost p.a. = Average stock level x ₦1.50

$$\text{Average stock level} = \frac{\text{Order Quantity}}{2}$$

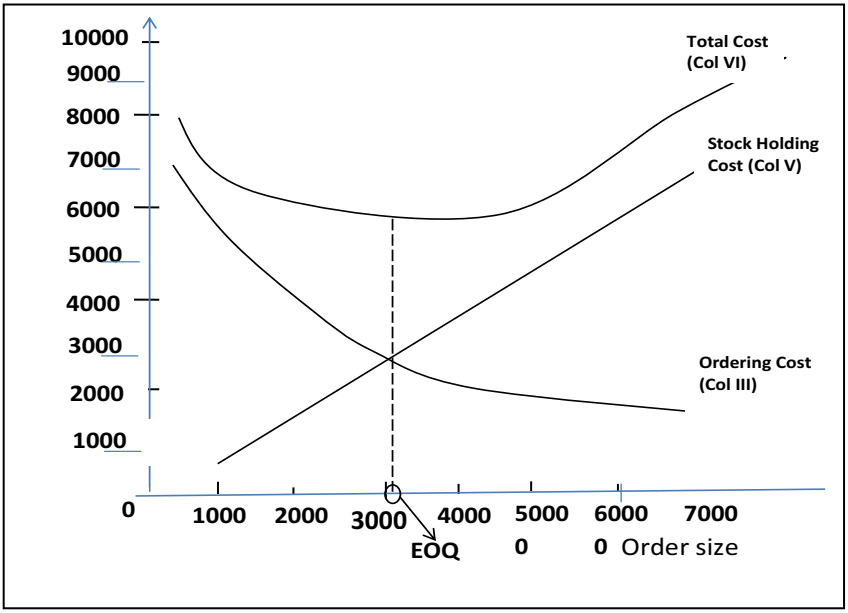
For example if the order quantity is 5,000:

$$\text{Carrying costs p.a.} = \frac{5{,}000 \times ₦\ 1.50}{2} = ₦\ 3{,}750$$

Based on the above principles, Table 1 below gives the cost for order quantities.

Column I	II	III	IV	V	VI
Order Quantity	Average No of Order p.a	Annual Ordering Cost	Average Stock	Stock Holding Cost p.a	Total Stock
	50,000/ Col. 1	Col II x N150	Col I/2	Col.IV x N1.5	Cols III + Col IV
1,000	50	7,500	500	750	8,250
2,000	25	3,750	1,000	1,500	5,250
3,000	$16\frac{2}{3}$	2,500	1,500	2,250	4,750
4,000	$12\frac{1}{2}$	1,875	2,000	3,000	4,875
5,000	10	1,500	2,500	3,750	5,250
6,000	$8\frac{1}{3}$	1,250	3,000	4,500	5,750

The costs in Table 1 can be plotted in a graph and the approximate EOQ ascertained as shown in the graph below.



From the graph it will be seen that the EOQ is approximately 3,200 widgets, which means that an average of slightly under 16 orders will have to be placed a year.

28. It is possible, and more usual, to calculate the EOQ using a formula. The formula method gives an exact answer, but do not be misled into placing undue reliance upon the precise figure. The calculations are based on estimates of costs, demands, etc. which are, of course, subject to error.

The EOQ formula is given below and should be learned. The mathematical derivation for Basic EOQ is:

$$EOQ = \sqrt{\frac{2 \times C_o \times D}{C_c}}$$

where: C = Ordering cost per order
D = Demand per annum
C = Carrying cost per item per annum

Using the data from Example 1, the EOQ can be calculated.
We have: C = N 150; D = 50,000 widgets;
C = N 10 x 15% = N 1.50 per widget

Notes:

i. The closest value obtainable from the graph was approximately 3,200 which is very close to the exact figure.

ii. Always take care that demand and carrying costs are expressed for the same period. A year is the usual period used.

iii. In some problems the carrying cost is expressed as a percentage of the value where as in others it is expressed directly as a cost per item. Both ways have been used in this example to provide a comparison.

EQUIPMENT MANAGEMENT

INTRODUCTION

29. In industry, Equipment Management generally caters for the machinery needs of an industrial enterprise and exercises an efficient control over their operation and supporting resources, to ensure that production is maintained at the requisite level with minimum overall costs. In the Defence Services, equipment management ensures that the right equipment is in the right place at the right time in the right quantity in the right condition and at the right cost.

30. All the stages of an equipment's life cycle namely, inception of an idea, design, development, trials, acceptance, procurement, allocation, usage, maintenance and finally discard requires top management or commanders' attention. The objective is maximum availability at minimum costs. In other words, achieving the requisite operational effectiveness at least cost to the exchequer. This calls for optimization of Reliability and Maintainability Standards and minimizing the maintenance efforts. This would need active participation and involvement of all the agencies connected with equipment management namely the General Staff, users, designers, producers, procurement and maintenance authorities.

LOGISTIC CONCEPT OF EQUIPMENT MANAGEMENT

31. The larger logistic concept of "equipment management" has the merit that it focuses attention on all the inherent activities namely selection, procurement, allocation, distribution, usage and maintenance or in other words all the activities from womb to tomb. In addition, it correctly emphasizes two vital factors viz., time and cost. Attempts to minimize cost in one field may have adverse

repercussions in other areas. Costs must be considered in their totality covering the complete life cycle of equipment. It may be worthwhile spending more money on design and development, trials and production to obtain a really reliable equipment but operational reliability and availability of weapons and equipment at all times would mean prohibitive costs and therefore, the term equipment management and its implications must be clearly understood.

32. The activities during the life cycle of equipment are:

a. Formulation of the requirement.
b. Design and development.
c. Manufacture of proto-types.
d. Technical and user trials.
e. Bulk production.
f. Issue to troops and in-service period.
g. Obsolescence, withdrawal and disposal.

33. From the above activities and factors it will be seen that many organizations are involved in the life cycle of an equipment or weapon system. The major ones are:

a. User.
b. General Staff.
c. R and D organization.
d. AHSPs.
e. Inspectorates.
f. Ordnance.
g. EME.
h. Finance.
i. Ordnance Factories.
j. Public and Private Enterprises.

GENERAL STAFF POLICY STATEMENT AND REQUIREMENTS

34. **General Staff Policy Statements**. Requirements of equipment up to 15 years are determined in relation to the appreciation of likely military threats during this period and are enunciated through General Staff Policy Statements (GSPS). These may be long term and short term. GSPS are either of a general nature or define in broad terms a family of equipment and their employment.

35. **General Staff Qualitative Requirements**. The operational requirement of individual equipment is laid down in General Staff Qualitative Requirements (GSQR) which aims at defining the weapons and equipment system and represents users view to the developer. A GSQR is formulated based on users requirements, combat concepts, and technological developments in home country and abroad. This is circulated to all concerned in the form of a draft Qualitative Requirement. The GSQR lays down in broad outline the following:

a. Likely deployment of the equipment.
b. Physical, technical and functional characteristics.
c. Number of prototypes required for trails.
d. Probable dates by which required.
e. Initial and recurring requirements.
f. Requirements of logistic support.
g. Maintainability and reliability requirements.

R AND D FUNCTIONS

36. R and D functions is one of the primary responsibilities of NAEME corps. For producing any major equipment indigenously, NAEME R and D team has to be associated right from the draft QR stage till the time the equipment is in production. Even after the equipment is introduced and is in the hands of the troops, it has to deal with design defects and suggest ways to overcome these. In

dealing with these aspects, R and D's detailed functions are:

a. Help in formulation of draft QRs.
b. Technical feasibility studies for finalizing the QRs.
c. Translation of QRs into technical specifications.
d. Build-up of the prototypes.
e. Technical evaluation by R and D.
f. Users trials and acceptance.
g. Technical assistance and advice in the production batch.
h. Design defect investigations and modifications during the in-service period.

37. To carry out the aforesaid functions effectively, it needs not only correct and timely policy decisions and directive from the topmost level but R and D unit level itself. It needs dynamic planning, co-ordination and prompts. Users/EME advice during the design, prototype manufacture and trials stage, so that reliable equipment could be offered to users in the optimum time and cost.

38. **Technical Feasibility Studies**. Once the draft QR is received, the parent design R and D establishment carried out certain layout studies to generally evolve the pattern of design and basic dimensions of equipment with a view to ascertain whether what is given in draft QR is technically achievable. It is here that for those layout studies which may involve in some cases even manufacture of mock-ups to study space requirement for the crew that the presence of the User's representative in Research Establishment is most essential.

39. **Design and Development Phase**. This is the most important phase for the R and D establishment where the General Staff QR is actually converted into hardware on the drawing board. The aim of the Scientist/Designer should to provide the full

operational needs of the Users at the lowest overall cost.

40. **Build-up the Prototype.** The build-up prototype could be done by the parent design R and D establishment or the agency which is ultimately required to do the bulk. Both have their own advantages and drawbacks. Even if the prototype build up is done by another manufacturing agency, the parent design R and D establishment cannot absolve itself of its moral responsibility of giving all technical guidance and financial help during the build-up stage so that the manufacture of prototype takes place smoothly and with least delay.

41. **Technical Evaluation**. Once the prototypes are ready, technical trials have to be conducted by the designers who lay down schedules to assess the performance, problem areas and so on. All the problem areas have to be removed before the vehicle/equipment could be offered to Users for acceptance. It is here that the EME representative could be most helpful.

42. **Users Trials and Acceptance**. These field trials have to be carried out by the Users to ensure that the User's requirements as defined in GSQR are fully satisfied and that the maintenance tasks can be carried out easily. During these trials, EME and the designers are naturally associated.

43. **Bulk Manufacture of the Equipment**. There is always a time lag between acceptance and its bulk manufacture. During this period, the designer will be conducting the endurance trials on the equipment to ascertain the reliability of the designer (where again EME/User representative will be associated) and also finalizing the design drawings for sealing.

44. **Defect Investigation during the In-service Period**. During the period when the equipment is actually in the hands of the troops, it is likely that a number of design defect reports are initiated by the users/EME which has to be tackled by the designers.

IMPORTANT EQUIPMENT MANAGEMENT TERMINOLOGIES

45. **Failure.** It is the inability of equipment to function correctly. Failure may be:

a. **Catastrophic or Complete**. Failure is said to be catastrophic or complete when equipment does not work at all.

b. **Partial or Wear Out Failure**. These failures are the result of general degradation of performance of the equipment. The equipment during this state works but does not perform as per designed specifications.

46. **Down-Time**. The time period for which equipment is not available for use, owing to the occurrence of a failure. The portion of down-time which may be attributable to preventive maintenance is sometimes referred to as maintenance down-time.

47. **Mean-Time-Between-Failure**. Mean-Time-BetweenFailure (MTBF) is the average time between two successive failures.

48. **Mean-Time-Repair.** Mean-Time-Repair (MTTR) is the average time taken to put failure equipment back to its operationally fit condition.

RELIABILITY

49. Reliability is the probability of successful operations of equipment or a system for specified period or usage under given

environments. Successful operations could mean 'failure free' operation or it could mean 'not more than a specified number of failures during that period'. For an aircraft on a bombing mission, a missile or a satellite, no repair en-route is possible. There is no alternative to failure for operation; even a single failure cannot be permitted. In this context, reliability would mean failure operation for specified period or usage. For equipment where repairs or replacement of failed components are possible (say vehicle), it may be more practical to specify the maximum number of failure acceptable within given period or usage. In such cases reliability is expressed a 'Mean Time-Between-Failure' (MTBF). With usage the chances of survival decrease and the likelihood of more components or equipment failure goes up. Some of the important facts about reliability are:

a. Reliability is different from performance. It demands repeatability of performance.

b. Reliability is not the same thing as quality. Two components, assemblies or equipment with identical performance and quality of components can have different reliability.

c. Reliability does not always mean 'failure-free' operation.

d. Reliability is quantifiable.

e. Reliability is an engineering discipline. With the same quality and quantity of material, two structures can have different reliability as it is governed by the various design conditions.

f. Reliability improvement is a continuous engineering process. This involves enormous amount of data collection, its analysis and initiation of quality control measure to further improve reliability.

50. Reliability of equipment can be best ensured by paying proper attention to this aspect right from the conceptual stage till the discard of the equipment from service.

MAINTAINABILITY

51. Maintainability is the probability that a device can be restored to operational effectiveness within a given period when maintenance action is performed on it in accordance with prescribed procedures. In other words design for ease of maintenance. It is a simple and old fashioned idea, one which is forgotten in a large number of instances. Maintainability is separate and distinct from reliability and sometimes its needs are opposite to those of reliability.

52. As the user begins to demand consistent and better performance (accuracy, sustained rate of operation amongst others) from his equipment, increasingly complex equipment have to be designed. Initial trials usually indicate a higher than acceptable failure rate, so design changes are made to reduce the number of parts – often by combining features of several parts. These composite parts make equipment more complicated to manufacture; so, the manufacturer introduces further changes for ease of manufacture or to take advantage of cheaper and faster mass production techniques and processes. Finally, sophisticated, highly reliable equipment is delivered for use. This equipment uses modules, sealed units, potting, welding and soldering etc to eliminate nuts and bolts or other fasteners. All these make repairs difficult and time consuming. Statistics are often produced to prove that it is cheaper to replace than to maintain. But this is not always so. Often components and assemblies have a substantial failure rate and need to be replaced.

53. The aim of maintainability is, therefore, to design and develop systems and equipment which can be maintained in the least time, at the least cost and with the minimum expenditure of support resources

without adversely affecting its performance or safety characteristics. The support resources are:

a. Manpower utilized.
b. Carried spare parts.
c. Tools and test equipment.
d. Services (e.g. spares support in terms of replacement of items covered by warranty). e. Quality Control.
f. Support facilities.

54. Two things militate against maintainability: firstly it cannot be put into a complex machine after the latter has been designed and manufactured. This quality has to put in at the design right from the beginning and this means engineering work, effort and expense. It means association of the service engineers with the design: secondly, maintainability does not improve performance. A vehicle will not run any better or carry any more pay-load nor will a wireless set have greater range simply because of its ease of maintenance. Under these conditions, it is difficult to create interest amongst the users or to motivate the designer to build maintainability into the machine.

AVAILABILITY

55. Availability is the probability that a particular equipment will be capable of adequate operations at any randomly selected time. Better reliability and higher maintainability contribute to higher availability of equipment. The best way to understand the various features of maintainability is to study its effect on availability. Equipment may have a certain built-in reliability which may result in, let us say, about 5 failures during period such as one year. The individual failure may be different in nature and may require for the repair different periods for repairs. If the total time required for the repair of all these failures is about 36 days, we can say that the

equipment was not available (36/360) x100=10% of the time i.e. the availability was 90%. Notice how the availability is influenced both by the frequency of failures as well as the time for repairs.

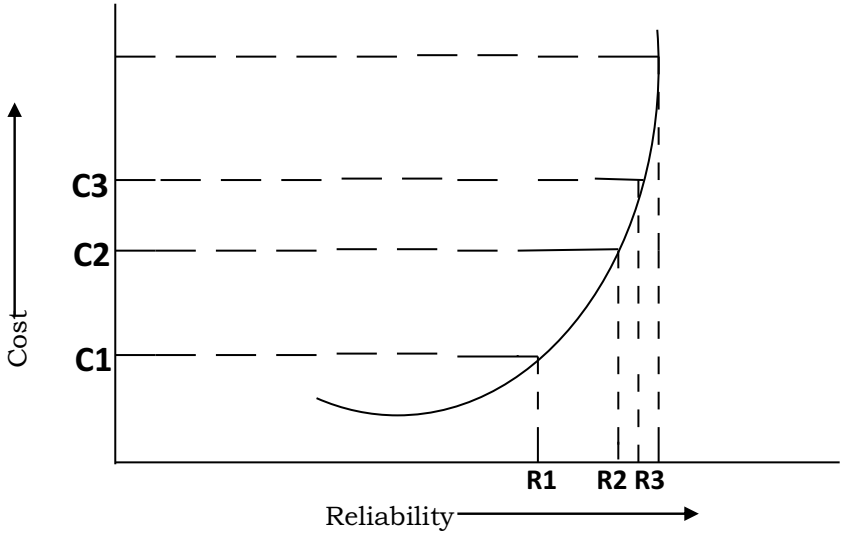


Fig. 1-1. Reliability – Cost Curve

IMPROVEMENT IN AVAILABILITY OF EQUIPMENT

36. As the main aim of various agencies associated with equipment is to increase the availability. Availability of equipment can be improved by any one or more of the following methods:

a. **Increasing the Reliability of Equipment**. Reliability can be increased by improving design, using better (more reliable) components or by improving the manufacture processes so that there are fewer breakdowns and lesser requirement of repair and maintenance actions. Building in better reliability, however, costs more money as shown in Fig. 1. Reliability can therefore be improved up to a point. Beyond that it becomes too costly to improve further. As such the designer has to 'trade off' reliability with the repair/maintenance costs over the life cycle of the equipment.

b. **Improving the Maintenance of Equipment**. Maintainability can be improved as mentioned earlier, by ensuring at the design stage, that the defective parts/assemblies can either be repaired without removing them from the main equipment or if these have to be removed, then these parts are easily accessible and can be removed and repaired speedily. Also the repairs can be affected by workers without acquiring any special skill, with the use of least number of special tools, and in the shortest possible time. This would require identification of parts which have high failure rates.

c. **Equipment Replacement.** The pattern of failure of equipment with usage can be represented by a 'Bath Tub' curve as shown in Fig. 1-2. The incidence of failure is high during the 'Break-In Phase' comes down and is almost constant during the 'Operating Phase' and then increases

suddenly during the 'Wear Out Phase. The equipment, therefore, increases the maintenance load on workshops enormously when it enters the 'Wear Out Phase' and demands more resources in manpower, spares and test equipment. As such resources are limited, putting back such equipment to operationally fit condition has got to be done at the cost of other failed equipment which requires lesser resources but has to wait in the queue for attention. Equipment entering 'Wear Out Phase' should, therefore, be identified and replaced with new or overhauled equipment so that the overall availability of the equipment does not get affected adversely.

d. **Standard of Maintenance and Repairs**. This is affected by availability of right types of manpower and its technical training, availability of correct tools and test equipment and right spares in right quantities at right places and at the right time. Availability of technical information (know-how) is another important factor which decreases the 'down-time' of equipment.

MAINTENANCE MANAGEMENT

37. Maintenance Management is an importan1t aspect of equipment management during the in-service period of the equipment. Maintenance management can be broadly divided into the following two sub-systems, namely; Preventive maintenance and Breakdown maintenance.

a. **Preventive Maintenance**. This maintenance is done before a need occurs or develops. The object of preventive maintenance is to minimize failures and breakdowns with consequent reduction in down time and maintaining the desired operational or mission reliability.

The concept of preventive maintenance must be correctly understood by all concerned down to the unit and LAD level.

b. **Breakdown Maintenance**. Experience indicates that no matter how much time and other resources are spent in preventive maintenance, breakdowns will still occur. Breakdown maintenance envisages provision of facilities that will be available for the repair of equipment that has failed and put it back into service with the least loss of time. For these purpose facilities exists in EME in the form of light, field and base workshops.

58. All types of maintenance need factual information to assist in their planning. It is necessary and useful to know how different equipment and their major assemblies and systems are performing under actual working conditions. Such information based on data studies will help in formulating preventive maintenance more effectively and also to predict deterioration or likely failures.

NETWORK ANALYSIS

INTRODUCTION

59. The term Network Analysis or Critical Path Analysis is a method whereby the policy to be adopted in carrying out a given task is represented by a graphical model in which the times necessary for completion of constituent parts are inserted. This model is analysed, the sequence of times which determine the total project time is extracted, and the times available for all constituent parts calculated. Once the task has begun, comparison of actual times with times available enables control to be exerted on the performance of the task. Network Analysis reduces the examination of a large project by breaking it down into individual jobs or events, arranging these in their logical sequence, estimating their costs and duration and making a network out of these to give the paths controlling the total period of the project and its cost.

60. Network methods are aimed at allocation of resources, re-allocation of resources to improve schedules and control the project from inception to completion. They are also used for planning. The development of Network Analysis went along two parallel streams, one military and the other industrial. The one used is the military is the Programme Evaluation Review and Technique (PERT) while the one used in the civil is Critical Path Method (CPM). The PERT method would be focused on in this module. Some applications of Network Analysis are as follows:

a. **Overhaul**. Plant, equipment, vehicles and buildings, both on routine and emergency basis.

b. **Construction**. House and offices, including all pre-contract, tendering and design work.

c. **Civil Engineering**. Motor ways, bridges, road programmes, including pre-contract tendering and design

work.

d. **Town Planning**. Control of tendering and design procedures and subsequent building and installation of services.

e. **Marketing**. Market research, product launching and the setting up and running of advertising campaigns.

f. **Ship Building**. Design and production of ships.

g. **Design**. Design of cars, machine tools, guided weapons, computers and electronic equipment.

h. **Product Change Over**. The changing over from one product to another during seasonal changes.

i. **Modification Programmes**. The modification of existing plant or equipment.

j. **Office Procedure**. Investigations into existing administrative practices, (for example, the preparation of monthly accounts) and the devising and installing of new systems.

k. The setting up and control of consultancy assignments.

ADVANTAGES OF NETWORKS

61. Network methods have the following advantages:

a. They enforce pre-planning.

b. They increase co-ordination.

c. They identify trouble spots and pinpoint responsibilities.

d. They focus management attention to trouble spots and hence enable management by exception. For example, activities behind schedule can be pinpointed and management can re-allocate its re-sources more effectively to regain lost time.

e. Facilitate handing/taking over during progress

of the project.

f. They enable revision of the plan and suggest areas for alternatives.

g. They allow for better control of the project.

h. They allow for better use of resources.

i. They allow for better scheduling and planning of projects.

j. They provide compact and comprehensive records.

k. They are important means of training personnel in the techniques of handling operations.

DEFINITIONS OF KEY TERMS IN NETWORK ANALYSIS

62. The following are definitions of important terms used in Network Analysis:

a. **Network**. This is described as a pictorial representation of the inter-relationships of all the required events and activities comprising a project.

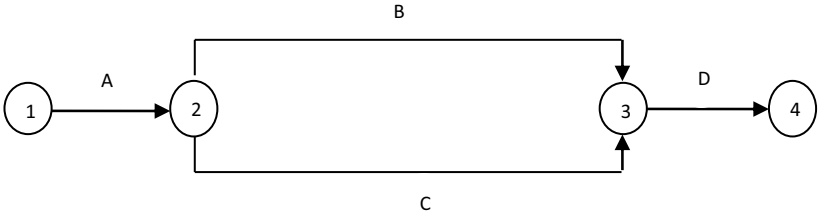
b. **Activity**. It is the actual job performed which requires the expenditure of time and other re-sources. For example, in building a house, excavating the foundation, pouring concrete, farming, wiring, plumbing etc. will form activities of the project. An activity lies between two events. It is represented by an arrow in the network.

c. **Event**. An event is an instant in time or a state in the progress of the project. An event marks the beginning of an activity, thus it is known as the tail event and it is also marks the ending of an activity which is called the head event.

d. **Dummy Activity**. Dummy or redundant activities arise when:

(1) Two parallel activities have the same tail and head events. This case may arise when two concurrent

activities are possible, as shown in Fig. 1.1



Concurrent Activities B and C

To get over the ambiguity, a dummy activity is introduced; see Fig 1.2

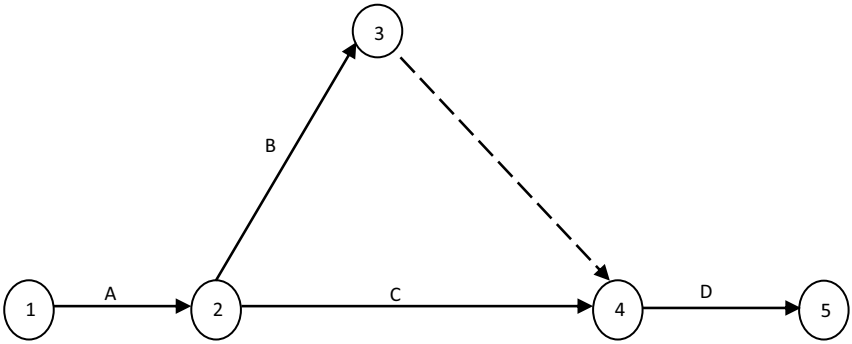


Fig 1.2 Dummy Activities Shown Dotted

(2) Two paths may have a common event and thus be dependent on each other as shown in Fig 1.3

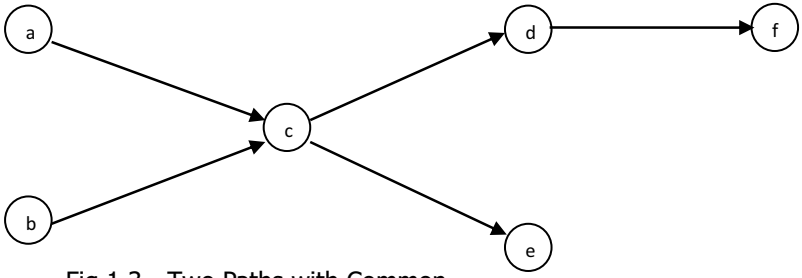


Fig 1.3 - Two Paths with Common Events

In case the commencement of activity c - d is independent of completion of the activity b – c then the network can be redrawn as given in Fig 1.4

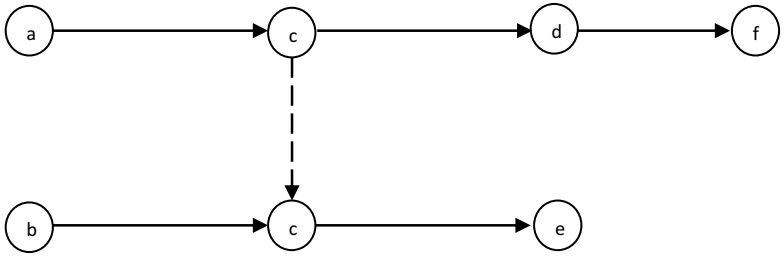


Fig 1.4 - Dummy Showing c - d as Independent of b - c 1

HINTS FOR DRAWING NETWORKS

63. It is often difficult to draw a neat network which is easy to follow, when the number of individual arrows becomes fairly large. Practice helps one to develop an eye for constructing networks. However, the following hints may be found useful:

a. Try to avoid drawing arrows which cross each other.

b. Try to keep all arrows in straight lines.

c. Try to avoid too wide a variation in the length of the arrows.

d. Try not to let rough estimates of duration influence the lengths of arrows.

e. Try to keep a left to right component of each arrow, in particular avoid back-slanting arrows if possible.

f. Use dummies as freely as you please in early drafts but cut any redundant dummies when the final version of the network is drawn.

g. It is usually necessary to list events and/or activities, giving descriptions and in the case of activities, duration times.

ANALYSING NETWORK CRITICAL PATH

64. The systematic analysis of a network sorts out the individual jobs into two main classes, critical and non-critical. Some of the non-critical jobs may be further classified as subcritical. In its later stages, the analysis may go on to investigate costs and also the allocation of resources. *Those jobs which contribute directly to the overall duration a/the project are called critical jobs or activities.* Consider for example, the network shown in Fig. 2-1 in which the unencircled figures represent duration in days.

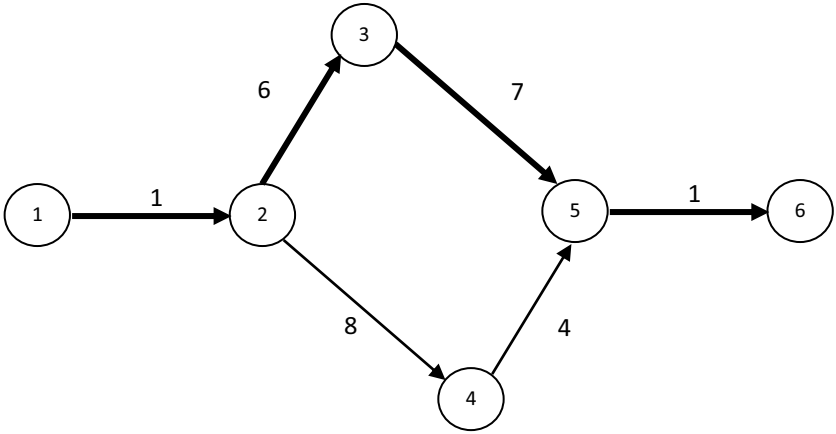


Fig 2.1 - Critical Jobs (Shown in Thick Lines)

65. The overall duration of the project is 15 days and the jobs represented by heavy arrows are critical. Any delay in completing them will cause a corresponding delay in the duration of the project itself. Conversely, by speeding them up, we may finish the project more quickly. These critical jobs form a chain running through the network, which is called the Critical Path. In any network, there is always at least one critical path and there may be more as the network becomes more complex. The critical path in the example just given is 1 - 2 - 3 - 5 - 6. If activity (4 - 5) were to take 5 days instead of 4 days, there would be a second critical path 1 - 2 - 4 - 5 - 6. All jobs or activities not on the critical path are non- critical. The critical events are those which lie on the critical path, and so in Fig. 2.1, all events but 4 are critical.

SUB-CRITICAL JOBS AND PATHS

66. Suppose that by allocating extra men to do job (3 - 5) in the above example, we reduce its duration to 5 days, then it would drop out of the critical path and jobs (2 - 4) and (4 - 5) would come into it.

In a case of this sort, jobs (2 - 4) and (4 - 5) are often classified as sub-critical jobs or activities and 2 - 4 - 5 as a sub-critical path.

ISOLATING THE CRITICAL PATH

67. In order to calculate the total project time, it is necessary to carry out a forward pass, that is:

a. Start from the left of the arrow diagram, that is, at the first event.

b. Give the first event a time "0". Note that this is not equivalent to saying that all emergent activities must start at time "0".

c. Proceed to each event in order and calculate the earliest possible time at which the event can occur. Note: If several activities lead into an event, the earliest time is fixed by the longest chain. This procedure is expressed in the following rule "To the earliest time of each immediately preceding event, add the duration of the activity which connects it and select the highest of the values obtained". For example, in the network shown in Fig. 3-2, if Event 1 is at Week 0, then Event 2 has an earliest time of 16 weeks.

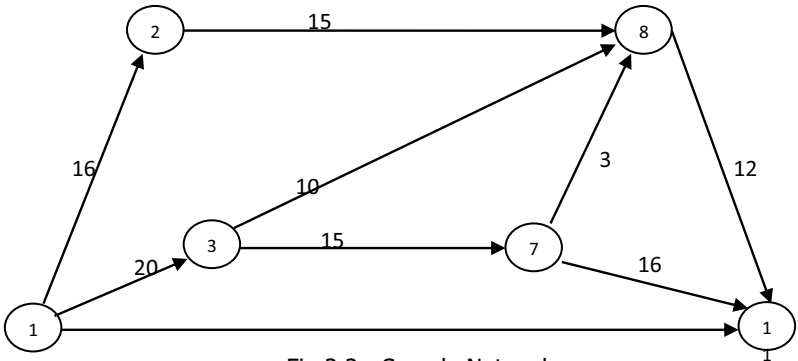


Fig 2.2 _ Sample Network

Event 8 has three chains leading into it:

(1)	1 – 2 – 8	(16+15) weeks.
(2)	1 - 3 – 8	(20+10) weeks.
(3)	1 - 3 – 7 – 8	(20+15+3) weeks.

and the earliest time for event 8 is determined by the longest chain and in this case, chain 1 - 3; 7 - 8 which has a combined duration of 38weeks. Hence the earliest time for event 8 is 38 weeks.

d. List these earliest event times.

Event No	**Earliest Time**
1	0
2	16
3	20
7	35
8	38
11	51

Clearly the total project time is given by the earliest time of the final event which in the above example is event number 11. Total project time is 51 weeks.

68. Continuing the analysis, the critical path can be isolated by carrying out a backward pass:

a. Start now from the right, that is, the last event.

b. Give to this event its earliest time - in the above example, week 51. This does not mean that all entering activities must finish at week 51.

c. By subtracting the duration times, calculate the latest possible occurrence time for any event, assuming the final event as fixed. By the latest possible occurrence time is meant the latest possible time at which an event can occur

without jeopardizing the total project time calculated above. As before, the latest event time is fixed by the longest chain leading into the event. Latest times of events are determined in descending order of event numbers, according to the rule: "From the latest time of each succeeding event, subtract the duration of the job which connects it and select the lowest of the value obtained". For example, in Fig. 2-2 above:

Event 11 has a latest time of 51weeks. Event 8 has a latest time of (51 - 12) weeks = 39weeks.
Event 7 has two chains leading out of it.
(1) 7 - 11
(2) 7 - 8 - 11
Latest time for chain (1) = 51 - 16 = 35 weeks
Latest time for chain (2) = 39 - 3 = 36 weeks
Hence latest time for event 7 is 35 weeks.

69. As a check on the accuracy of calculation of event times, it should be noted that the difference between the earliest and the latest event times for the final event must be the same as the difference between the earliest and the latest event times for the first event. The critical path lies along those activities whose earliest and latest times for the tail events and head events are the same, and whose duration times are equal to the difference between the head and tail event times. In the above example, the critical path lies along path 1 - 3 - 7 - 11.

AUTOMOBILE GENERAL

LUBRICANTS

70. The purpose of engine lubricating system is to supply the engine components with an adequate amount of lubricating oil under a guaranteed pressure in the process. The exposure of the lubricating oil to high thermal, chemical and mechanical condition in the engine causes it to be stressed. Additionally, mechanical contamination through dust, metal abrasion and combustion residues regularly contaminate oil, thus the need for regular oil changes.

71. **Types of Fluids and Lubricants**.

a. Liquids and Gaseous Fuel e.g Petrol, Diesel fuel, Natural gas and Hydrogen.

b. Oil and Lubricants e.g Motor oil, Grease and Graphite

c. Coolants and Antifreeze e.g Water, Ethylene Glycol, R134a refrigerant, Dry ice and Liquid Nitrogen. d. Brake Fluids e.g Glycol ethers.

e. Fluids for force-transfer e.g ATF, Silicon fluids and Hydraulic fluid.

72. **Functions of Lubricating Oils**. Lubricating oils must have or possess the following qualities:

a. Ability to lubricate.
b. Ability to cool.
c. Ability to clean (as detergent).
d. Ability to protect against corrosion.
e. Ability to reduce noise.
f. Ability to seal.

73. **Properties of Lubricating Oils**.

a. **Viscosity**. This serves as an index of oil flow properties by quantifying its internal friction. High fluid, free-flowing oil have a low viscosity and also a low resistance to displacement forces. High viscosity oil on the other hand exhibit higher flow resistance

b. **Kinematic Viscosity**. The kinematic viscosity property is measure in the capillary viscosity meter. A defined quality of the oil flows through along the tube at a defined test temperature.

c. **Dynamic Viscosity**. This is a low temperature viscosity that can be measured in pressurized capillary viscometer or in a rotation viscometer.

d. **Shear Rate**. This is the velocity of a moving object divided by the depth of the lubricant layer. Oil is subjected to different or various shear stresses at a lubrication orifice.

74. **Engine Lubrication Components**.

a. Oil pan (sump).
b. Oil pump.
c. Pressure-limiting valve.
d. Oil filter.
e. Oil-pressure gauge.
f. Ventilation.
g. Overflow valve.
h. Oil cooler.

75. **Gear Lubricants**. Gear Oil is a lubricant made specifically for transmission, transfer cases, and differentials in automobiles, trucks, and other machinery. It is of a higher viscosity to protect the gears and it's usually associated with a strong sulfur smell. Function and properties of Gear

Lubrication are as follows:

a. Wear protection on gear teeth flanks and on bearing

b. Different friction properties (within the synchronized gearbox, the synchronization process relies on displacement of oil film between synchronizers cone and ring).

c. Protection ageing extending throughout the service life.

d. Suitability for use with gasket and seal materials, such as elastomers.

COOLING SYSTEM

76. Cooling is achieved in engines using the Air Cooling or Liquid Cooling methods. These methods are discussed below.

77. **Air Cooling**. In the case of air cooling, the cooling heat to be removed is dissipated from the surfaces of the engine components directly to the ambient air flowing past. Other types of Air Cooling system include; Airstream Cooling which is the type of air cooling method frequently used on motorcycles since the airstream flows around their unfired engines. In the interest of obtaining the greatest possible level of cooling, the transfer of heat to the ambient air is improved by increasing the effective cooling surface with cooling fins. Forced Air Cooling is another type of Air cooling method adequate for cooling of engines around which the airstream does not flow. A fan is driven by the engine via a V-belt and cools the individual cylinders with the aid of baffles uniformly with the cooling air (e.g. motor scooters).

a. **Advantages of Air Cooling**.

(1) Simpler design

(2) Lower weight-to-power ratio

(3) No coolant with anti-freeze required
(4) Extensively maintenance free

b. **Disadvantages Of Air Cooling**.

(1) Great fluctuations in the operating temperature.
(2) Power requirement of the radiator fan is comparatively high (Approx. 3 - 4% of engine power).
(3) Louder noises emanating from the fan due to the lack of a coolant jacket.
(4) Greatly delayed and non-uniform passenger-compartment heating.
(5) Poorer heat transfer between cooling fins and air.
(6) Cannot be regulated.

78. **Liquid Cooling**. In the case of liquid cooling, the heat is removed by a cooling liquid (coolant). The coolant absorbs the component heat and dissipates it via the radiator to the ambient air. Liquid-cooling system without Pump can be achieved if the flow operation is achieved exclusively by the change in coolant density; this is known as natural circulation cooling or thermo-siphon cooling. When a hot engine is switched off, this effect is utilized for further cooling based on the fact that hot water has a lower density than cold water and therefore rises.

a. **Advantages of Liquid Cooling**.

(1) Uniform cooling effect.
(2) Good damping of the combustion noises by the cooling jackets.

(3) Provides for good heating of the passenger compartment.

b. **Disadvantages of Liquid Cooling**.

(1) Relatively high weight.

(2) High maintenance required.

(3) Longer war-up period until the operating temperature is reached.

(4) The Water Pump too would require cooling.

FILTERS

79. Filters are parts installed in motor vehicles to guard against contaminants and impurities by providing protection for the engine, other vehicle components and the vehicle occupants.

80. **Types of Filters**

a. Air and Exhaust gas filters

b. Fuel filters

c. Filters for lubricating oils.

d. Interior filters (Such as pollen and ozone filter)

e. Hydraulic filters (ATF and Power steering)

81. **Functions of Filters**.

a. They help prevent premature degradation of lubricating oil by filtering out suspended contaminant.

b. The structure and operation of the oil filter are basically the same as those of the replaceable fuel filter.

c. Filter elements remove particles down to a diameter of roughly 10μm.

d. Contaminants suspended within the oil, such as metal particles, soot and dust reduce the oil quality, leading to increased wear.

e. The oil filter makes it possible to extend oilchange intervals while simultaneously providing enhanced cooling for the circulating oil.

f. They also have no effect on chemical and physical changes that may occur in the oil during engine operation, such as ageing.