MANNUAL ON RESCUE TECHNIQUES AND OPERATIONS-1993

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CHAPTER 1

ORGANISATION AND FUNCTIONS OF CIVIL DEFENCE ENGINEERING SERVICES

1. **General**-The future wars are likely to be characterised by high-tech and intracity encompassing a variety of sophisticated weapon systems like Fuel Air Explosive. Multiple Warhead Rockets and Auto-guided Missile systems. Liberation of Kuwait by the allied forces in 1991 brought to Tight the kind of destructive power that such a war would leash out. The enemy air raids during futuristic wars thus are likely to cause extensive damage to buildings and other structures, resulting in trapping of large segment of the population under debris and various voids formed in the damaged structures. The essential services like water, electricity and sewage too would not escape the effects of intense air raids. Indiscriminate bombing is likely to create craters leading to road blocks thereby disorganise the lives of the citizens.

2. Under such a scenario Civil Defence Engineering Services assume paramount importance Major functions of the Civil Defence Engineering Service would involve:-

(a) Rescue trapped persons from damaged buildings
(b) Salvage property.
(c) Repair and restoration of essential services.
(d) Demolish/Repair dangerous structures.

3. Civil Defence Engineering Services encompass the following major and important Services :-

(a) Rescue service.
(b) Salvage service.
(c) Repair and demolition service
(d) Services for repair and essential services.

RESCUE SERVICE

4. **Functions**- The major functions of the Service are :-

(a) Rescue trapped individuals from debris and damaged buildings.

(b) Render first aid and despatch them for further medical attention if required

(c) Provide temporary support to dangerous structures rendered due to air strikes.

(d) Demolish damaged structures that are likely to endanger life or obstruct smooth functioning of the service itself.

(e) Terminate water, gas and electricity connections from damaged buildings.

(f) Recovery of dead.

5. **Organisation** - An Officer Commanding Rescue Services is appointed for each town. He should be a responsible officer possessing sound technical knowledge of rescue operations. Should the nominated officer be unable to devote whole of his time to the services, he should be provided with necessary staff. The Staff Officer so provided should be adequately qualified in constructional matters and be made responsible for the organisation and administration of the service, enrolment and training of personnel and maintenance of records. Personnel for the Rescue Services are recruited from the Home Guards and the building trades on account of their practical knowledge.

6. Rescue Parties are located at Combined Civil Defence Depots alongwith other services under the command of a Rescue Group Leader with adequate knowledge of Civil Engineering Each Rescue Party consists of 8 men. These parties are provided on a scale of 1 per 25,000 population with additional reserve of 25% Adequate transport is provided to each rescue party for carriage of men and material. Rescue Parties are trained in rescue techniques and operations by a specially trained instructor.

7. **Operational Procedure** -On receipt of a report of damage after an air strike from the Warden the rescue parties are rushed from the Combined C.D. Depots to the scene of incident. On obtaining the required information with regard to the casualties, the rescue party leader formulates his line of action and commences rescue operations systematically, to include search, rescue administration of first aid and disposal of dead. If the structure appears to have been rendered dangerous by air raids shoring/demolition work is also undertaken by the party. Generally extensive demolition is not undertaken.

SALVAGE SERVICE

8. Due to large scale destruction and damage caused to buildings by air bombing, large quantities of valuable property may get buried under debris. For its retrieval a separate post-raid organisation known as the 'Salvage Organisation' is sprang into action, which is responsible for salvaging care and its subsequent disposal.

9. Such organisations are created in every town and function under a responsible officer in charge for Salvage Operations through the local Public Works Department or Rescue Parties. Some of the important arrangements required for salvaged properties are:-

(a) Arrangements for its custody under a custodian.

(b) Provision of godowns for storing and guarding of salvaged property.

(c) Prevention of property from weathering effects.

(d) Maintenance of accounts and records.

10. In order to facilitate performance of tasks by the custodian, he is provided with necessary stall, equipment, transport and labour. The task force is divided into salvage parties who generally function under the presence of police and a magistrate. Officers entrusted with the task of salvage and custody are supported by legal provisions.

REPAIR AND DEMOLITION SERVICES

11. **Repair to property**- After an air raid, a large number of buildings may become damaged rendering occupants of those buildings homeless. Though, rest centres will be organised where such people will be given temporary shelters, the solution lies in repairing the houses and making them habitable. Such repairs should not extend beyond that which is necessary to render the buildings fit for habitation.

12. **Repairs to roads** -Buildings, roads, bridges and culverts are likely to be damaged by high explosive bombs during air raid and if they are not quickly repaired they would affect communication between different parts of a town and be a severe handicap to Civil Defence Services.

13. **Demolitions**- Some buildings damaged during air raids might be rendered dangerous and constitute potential source of danger to the public. Their presence near road side might endanger lives and traffic on the roads. Such buildings may, therefore, have to be demolished in the larger interest of the community.

14. Arrangements must, therefore, be made with the local Public Works Department authorities, who should set up Repair and Demolition Squads for this purpose under their control to ensure that the necessary stock of materials and implements are available to undertake the repairs as soon as possible.

SERVICES FOR THE REPAIRS OF ESSENTIAL SERVICES

15. The destruction and damage caused to the Essential Public Utility Services, as a result of enemy air raids, would not only seriously impede the working of other services but also disrupt the normal life of the citizens. It is essential to the war effort to keep the essential public utility services functional. The responsibility for repairs and restoration of essential services will be that of the utility managements concerned who should work in close co-operation with the Civil Defence authorities for co-ordination of the emergency repair and restoration of the services. The following are the main public utility services :-

(a) Water.
(b) Electricity.
(c) Town Gas .
(d) Sewage System.

16. **Water**- Maintenance of water supply is most essential in war time as water will be needed for firefighting drinking, cooking, washing, sanitation and Industrial undertakings

17. **Electricity**- Electricity has so permeated every phase of modern life that it will be difficult to be without it even for a short time. Functioning of production machines essential hospital equipment and some of the public utility services in many cases depend on uninterrupted supply of electricity, Therefore, any interruption of this service will affect several other services which must be kept going.

18. **Town Gas**-Damage to gas may give rise to the possible risk of fire and explosion. Maintaining this service in order will also help to solve fuel problems which may become acute during war.

19. **Sewage System -** Failure of sewage system can have very serious repercussions on public health and well-being. It will also severely hamper the carrying out of essential civil defence operations. It is, therefore, essential that measures should be devised whereby the disposal of sewage can be maintained.

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CHAPTER 2

ORGANISATION AND FUNCTIONS OF RESCUE SERVICES

1. **Introduction-** Due to the sophistication achieved in the technology of modern weapon system and their devastating effects, there is likely to be considerable damage and loss to structures and buildings in future wars. This might result in a large number of people getting buried/trapped under debris. Essential services may be damaged and the communication system blockaded, leading to disorganisation of normal life of citizens. It is during such situations that the role of rescue party attains importance.

OBJECT OF RESCUE SERVICES

2. The primary object of the Rescue Service is to rescue living persons trapped in debris. It is also responsible for the recovery of the dead from damaged buildings and to take such immediate steps as may be necessary for the temporary support or demolition of buildings, the collapse of which is likely to endanger life or to obstruct traffic. The Rescue Service should not normally undertake extensive demolitions or demolitions involving extensive use of explosives. It may however undertake any suitable work provided its ability to carry out its primary task is not affected. The work of rescue requires experience and care, since debris unskilfully moved may release other parts of the structure and so cause it to crash upon both rescuers and those to be rescued. Personnel for the Rescue Parties should be recruited from the Home Guards and the building trades on account of their practical knowledge. All members of Rescue Party should be trained in first aid.

ORGANISATION OF RESCUE SERVICE

3. The organisation of Rescue Service in a town is as given below:

(a) Officer Commanding	1 per town
(b) Staff Officer	1 per 15 parties
(c) Clerks	1 per OC & 1 per Staff Officer
(d) Rescue Parties	1 per 25.000 population (of 8 members each) plus 25% reserve
(e) Leader	1 per party
(f) Skilled men	2 per party
(g) Unskilled men	4 per party
(h) Driver	1 per party
(i) Vehicle	1 per party
(j) Group Leader	1 per Depot.

4. The Rescue Services will be provided by the Home Guards Organisation by providing requisite training to its members. The rescue party consists of both skilled and semi-skilled personnel like layers, masons, carpenters, plumbers with adequate experience. Professional technicians are also included for maintenance and running of the essential service. The rescue parties will be located in depots along with other relief parties.

FUNCTIONS OF RESCUE SERVICE/PARTY

5. The functions of a rescue party are:

(a) To rescue living persons trapped beneath debris or damaged buildings.

(b) To render first aid to such trapped/injured persons at the site of incident and hand them over to the F. A. Party.

(c) To recover the dead from damaged buildings.

(d) Provision of temporary support or demolition of damaged structure, where collapse may endanger life, obstruct traffic or hinder work of rescue party/other services.

(e) Cut off essential services from damaged buildings.

(f) To remove debris where necessary.

DUTIES OF THE MEMBERS OF RESCUE SERVICES

6. The duties of various members of a rescue service are:

(a) **Officer in charge Rescue Services-** The OIC Rescue Services should be an officer with sound technical knowledge of rescue operations. It is suggested that either the Executive Engineer of State PWD or the District Commandant Home Guards be made the OIC of Rescue Service. The reasons for appointing the Executive Engineer from the local PWD as OIC being his technical qualifications. As regards the Commandant Home Guards, his involvement in deployment of manpower for this service from the Home Guards Organisation, would lead to better co-ordination and Man Management. The major duties of the OIC Rescue Service are:

(i) Responsible for manpower planning and equipment assessment for rescue service in his town including reserve.

(ii) To ensure that all rescue parties are provided with vehicles for their movement and stores are earmarked party wise.

(iii) To earmark Group Leaders in various Depots for the rescue parties held in each depot and to choose the leaders of each rescue party.

(iv) Ensure adequate training is given to all rescue party members.

(b) **Group Leader**- The Group Leader is the overall in charge for all rescue parties located in a depot and he should be a person with knowledge of civil engineering. The major duties of the Group Leader are:

(i) To co-ordinate deployment of various rescue parties as per orders of the Depot Superintendent.
(ii) Organise training of rescue parties.
(iii) Regular maintenance of stores and equipment of rescue parties.
(iv) Ensure serviceability of all vehicles.
(v) Responsible to command all rescue parties in a depot.
(vi) Take over the technical operations of rescue work at major incidents in case it is necessary.

(c) **Staff Officer**- One Staff Officer at the scale of 1 per 15 rescue parties is provided to the Officer Commanding. The officer so selected should be a qualified Civil Engineer. Major duties of the Staff Officer are:

(i) Respond to the orders and instructions of the OIC.

(ii) Responsible for organisation, administration and logistics of rescue service.

(iii) Conduct enrolment and training of the personnel within the policies laid down by the OIC.

(iv) Maintenance of records for which he will be authorised additional clerk.

(v) Take over technical operations of rescue work at major incident in case necessary.

(vi) Officiate as leader in the absence of the group leader.

(d**) Leader**

(i) The leader of the rescue party is responsible for the efficient functioning of the party at the depot and at the scene of occurrence.

(ii) To act as a link between the men and senior officers.

(iii) To motivate his party into a cohesive team.

(iv) To ensure all instructions received from superior officers are meticulously implemented,

(v) Organise the work and to train and direct his men for carrying out the job smoothly and effectively.

(vi) To exercise proper command and control.

(vii) To check and maintain all stores/equipment.

(e) **Deputy Leader**- One of the members of the rescue party will be nominated as Deputy Leader and his major duties are as follows:

(i) He will act as Second-in-Command to the leader of the party.

(ii) He is responsible to get the stores unloaded from the vehicle and keep the rescue party ready for action at the place of incident when the leader is involved in survey work.

(iii) He will act as a Sub Group Leader wherever it becomes necessary for the party to work at two places.

(iv) He will officiate as leader in the absence of the leader.

(f) **Driver**-The major duties of the driver are:

(i) To keep the vehicle in the highest state of mechanical fitness and report any faults thereof.

(ii) Ensure all equipments are correctly loaded and stowed in the vehicle..

(iii) Supervise loading/unloading as per directions of Leader/Deputy leader.

(iv) Act as Store Keeper of the equipment at the site of incident.

(v) To assist in rescue operations as per orders of the Leader.

(vi) Account for all stores loaded at the site of incident is as per original inventory.

(vii) He is to ensure that there is no pilferage of any equipment from the vehicle.

(viii) Ensure that no unwanted stores are unloaded.

(ix) The driver should strictly follow the Marshalling Plan.

(x) At the site of incident ensure that the vehicle is parked keeping the following in mind:-

(aa) Freedom from effect of gas/radioactivity.
(ab) Ease of unloading.
(ac) Keep regard to turning radius
(ad) Convenience of other vehicles.
(ae) Non-obstruction of Hydrants.
(af) Not to block the path of other relief parties.
(ag) Protection/Security of vehicle.

(xi) Shift position of parking if ordered by police officer/warden or by any other responsible person.

EQUIPMENT CARRIED BY RESCUE PARTY

7. The details of major equipment carried by the Rescue Party are:

(a) Per Rescue Party.

(i) Iron shod levers, 10 ft. long	2
(ii) Heavy Block for Fulcrum	1
(iii) Crowbars	2
(iv) Picks	2
(v) Shovels (or Phawrahs)	2
(vi) Half round files	2
(vii) Sledge Hammer	1
(viii) Heavy Axe	1
(ix) Light axe	1
(x) Two handled cross-cut saw	1

(xi) Hand Saw	1
(xii) 100 ft. length, 3 in. fibre rope	1
(xiii) 100 ft. length 5/8" wire rope	1
(xiv) 40 ft. length 1½" fibre lashing lines	2
(xv) Chain tackle	1
(xvi) Single sheave snatch block	1
(xvii) 20 ft. bamboo ladders	2
(xviii) Petromax lamp	1
(xix) Torches electric	2
(xx) Hurricane lanterns	2
(xxi) Tarpaulin 12' x 12'	1
(xxii) Box of miscellaneous tools	1
(xxiii) Set of rope tackle, 3 sheaves-2 sheaves	1
(xxiv) Jack with 5 ton lift	1
(xxv) 20 ft. length of fibre ropes 1½"	6
(xxvi) Rubber gloves (pair) (tested up to 25000 voltage)	1
(xxvii) 200 ft. length fibre rope 3 or 4" (when needed)	1
(xxviii) Stretcher harness (set)	1
(xxix) Scaffold poles for sheer legs	3
(xxx) Debris baskets	6
(xxxi) Fireman's axes (with carrying pouches)	1
(xxxii) Short ladder (8 or 10 ft)	1
(xxxiii) Buckets	3
(xxxiv) Tarpaulins or stout canvas sheets 12' x 12' (to protect trapped persons from falling debris until released)	1
(xxxv) Leather gloves	2 pairs
(xxxvi) First aid pouches	2
(xxxvii) First aid box	1
(xxxviii) Stretchers	2

(b) Contents of Pouch for Rescue Party (2 per Party).

(i) Bandages triangular	9
(ii) Canes for tightening improvised tourniquets	3
(iii) Dressing Shells	6
(iv) Dressing First Aid	6
(v) Labels, casualty identity, packets of 20	1 packet
(vi) Safety pins (large) Cards of 6	3
(vii) Scissors	1 pair
(viii) Tourniquet	1

(c) **Contents of First Aid Box for Party (1 per Party)**

(i) Bandages, triangular	12
(ii) Canes, for tightening improvised tourniquets	5
(iii) Dressing Shells	6
(iv) Dressing. First Aid	6
(v) Lints, unmedicated, in squares about 18' x 18'	6
(vi) Safety pins (large) Cards of 6	4
(vii) Clasp Knife	1

(viii) Tourniquets	2
(ix) Splints, leg	2 set
(x) Scraps for leg splints	14

(d) Personal equipment per member of Party

(i) Helmet	-	1
(ii) Water bottle with sling	-	2

(e) Heavy equipment maintained in Depot (Normally 2 sets) per Depot

(i) 3 ton lifting tackle	1
(ii) 6 ft chains (3 ton lift)	2
(iii) Portable acetylene cutting outfit (where needed) with asbestos blanket (to be arranged from local resources)	1
(iv) Extension Ladder (35' complete)	1
(v) Hydrant keys	2 set
(vi) Air breathing apparatuses 8. Recommended Additional Equipment for Rescue Party	2

8. **Recommended Additional Equipment for Rescue Party.**

(a) Delivery operating lamps	6
(b) Power Saw	1
(c) Power Driller	1
(d) Power Cutter	1
(e) Jumping cushion	1
(g) Explosive	1 lb.
(g) SWR	50 mtrs.
(h) Cage	1
(i) 3 core cable with fitments	100 mtrs.
(j) Bulbs for emergency lighting	10 Nos.
(k) Self rescue racks	2

LOADING/UNLOADING RESCUE VEHICLE

9. **General-** The rescue party equipments have to be carried by the Rescue Parties in their vehicles. These have to be unloaded and reloaded into the vehicle under very strenuous and confused circumstances. In order to ensure that the members of the Rescue Parties can do this task with speed and without confusion, it is essential that some drills for the purpose are introduced and practised by them. The following drills have been designed to give the required practice to the Rescue Parties

10. **Drills**

(a) **Drill No. 1-Falling in and Numbering**

(i) **"Fall in"**

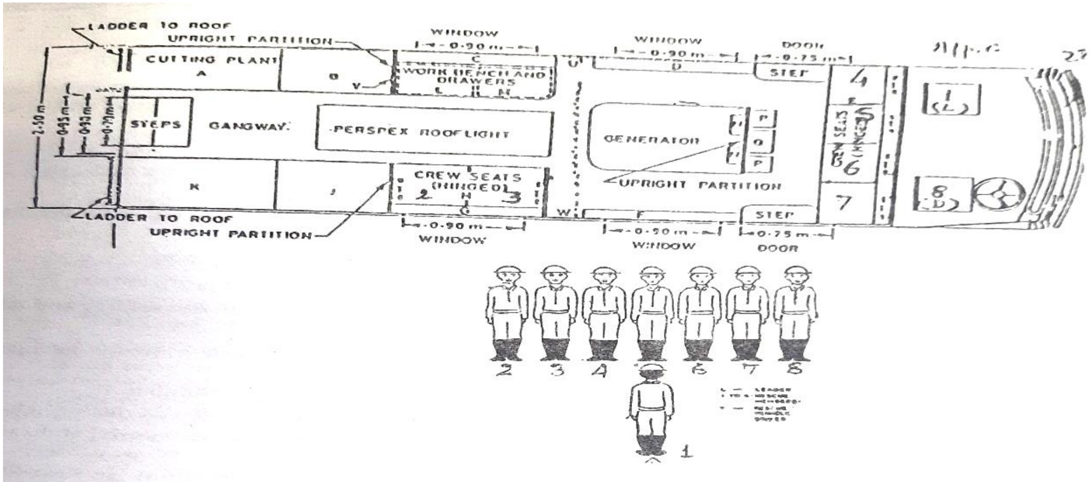
(aa) Order-Leader gives the command "Fall in".

(ab) **Action by the Rescue Party**-All members proceed to the vehicle and form up in single rank, the Deputy Leader to the rear and the driver to the vehicle front, on the off side, approximately one pace from the vehicle facing outwards.

(ii) **"Numbering"**

(an) **Order**-Leader gives the command.

(ab) **Action by the Rescue Party-**The members commence to number. Number 1 calls out "ONE" followed by the remainder of the party calling out "TWO", "THREE", "FOUR" etc. in succession up to Number 7 of the driver.



(b) **Drill No. 2-Mounting**

(i) **Order**-Leader gives the command "Party Mount".

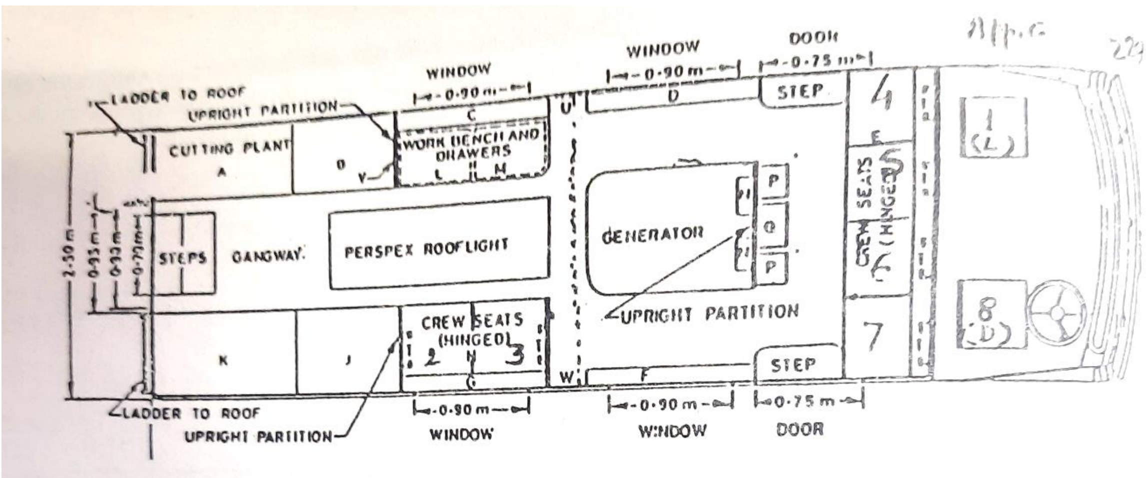
(ii) **Action by the Party**.

(aa) No. 8 (Driver) takes up his position behind the driving wheel. (Right front door entry).

(ab) No. 7 & 6 turn about and occupy seats as indicated in the picture below. (Right door entry). (ac) No. 4 & 5 turn to their left and occupy their seats on the double circling the engine compartment. (Left door entry).

(ad) No. 2 (Dy. Leader) & No. 3 turn right, occupy their seats on the double inside the body of the vehicle. (Rear door entry).

(ae) No. 1 (Leader) after the complete party has mounted the vehicle occupies the Co Driver's seat (Left front door entry).



(c) **Drill Number 3-Dismounting**

(i) Order-On arrival at the chosen position for drills etc. the Party Leader will dismount, take up a position facing the vehicle approximately 3 to 4 paces from it and gives the command "Party Dismount".
(ii) Action by the Party

(aa) The Leader (No. 1) dismounts from Co-Driver's seat and comes to the right side of the vehicle and stands facing the vehicle.
(ab) All Nos dismount through their respective doors and fall into the right of No. 8.

(d) Drill Number 4-Preparing to unload Equipment (For Inspection only).

(i) **Orders**-Party Leader gives the command "Prepare to unload".

(ii) **Action by the Party**-The whole Party turns to the REAR of the vehicle and takes up positions as follows:

(aa) Number 7 (driver) enters vehicle from the REAR and proceeds to unload all boxes/lockers. (ab) Number 6 follows and also enters vehicle to assist Number 7.
(ac) Number 5 positions himself opposite to the REAR off-side facing inwards.
(ad) Number 4 proceeds to the rear of the vehicle and positions himself at the rear off side facing the vehicle.
(ae) Number 3 proceeds as for Number 4 and positions himself at the Rear Centre of the vehicle facing it
(af) Number 2 proceeds as for Numbers 3 and 4 and positions himself at the Rear Near side facing the vehicle.
(ag) Number 1 proceeds to the position opposite the Rear Near Side facing No. 5 inward.

(e) Drill Number 5-Unloading Equipment

(i) Order.-Party Leader gives the command "UNLOAD EQUIPMENT".
(ii**) Action by the Party**

(aa) Number 6 releases the Extension Ladder, which is lowered by him and received by Numbers 2 and 4.

(ab) Number 6 lowers short ladders, iron shod levers and derrick poles which are received by Numbers 2 and 4.

(ac) Number 7 assisted by Number 6 unloads all equipments from inside vehicle commencing from the rear and working forward handing equipments to Numbers 2, 3 and 4 who place it in the inspection position on the ground.

(ad) Number 5 removes equipments stored on off-side and place it in the inspection position on the ground.

(ae) Numbers 4.3 and 2 will take over equipments handed out from the inside of the vehicle by Numbers 7 and 6 and place it in the inspection position on the ground.

(af) Number I will remove equipments stored on rear side and place it in the inspection position on the ground. When all equipments have been unloaded, the members of the party return to the "FALL IN" position. The equipment is then inspected and checked by the Party Leader.

(f) Drill Number 6-Preparing to load Equipment.

(i) **Order-**When equipment has been inspected and checked, the Party Leader will give the command "PREPARE TO LOAD".

(ii) Action by the Party-All members will proceed to the positions as detailed in Drill Number 5 (Preparing to unload Equipment) and will await further commands.

(e) Drill Number 7-Loading Equipment

(i) Order.-Leader gives the command "LOAD EQUIPMENT
(ii) Action by the Party

(aa) All members will load on to the vehicle the equipments previously unloaded by them.

(ab) Numbers 7 and 6 proceeding inside the vehicle to store equipment as it is handed in by Numbers 2, 3 and 4.
(ac) Equipments from the top of the vehicle, such as ladders etc. will be loaded last and secured by Number 7 assisted by Number 6.
(ad) When vehicle is loaded, Number 7 will secure all lockers/boxes. The crew will "FALL IN" and Number 1 reports to Leader.

11. **Layout out of Equipment for Inspection-** To enable the Leader to check up easily, equipment is laid out in the same position as it was in the vehicle, ie. equipment from the sides to be kept to the sides on the ground, equipment from the centre to be kept at the centre and all the stores and ladders to be kept at the centre leaving a clear space between the rows of equipment, so that the checker can easily go around without trampling the equipment. To ensure that equipment is not laid out too close to the vehicle. the Leader will take two full paces from the rear of the vehicle to make the position of the head of the ladder.

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CHAPTER 3

MANPOWER RESCUE EQUIPMENT

1.**Introduction**

Civil Defence organisation in the country today does not have a standardised pattern of Manpack Equipment This is considered to be an essential requirement during rescue operations under all conditions. The recommended pattern of personnel webbing equipment akin to the Army can be adopted which consists of belt, braces, pack, pouch, carriers and pack. This equipment would facilitate removal and replacement of any equipment. During operations it can be lifted and carried without difficulty

EQUIPMENT ASSEMBLING AND FITTING

2**(a) Belt**-The belt consists of three parts: back right and left sides. The bottom edge of the belt has eyelets, and the inside of the belt has slots at % inch intervals. To fit the belt together, place the back part on top of the right and left sides (slots uppermost) and engage the hooks on the sides in the convenient slots on the back. Then fit to the waist, adjusting hooks into fresh slots as necessary. The fireman's axe pouch should be fitted to the back part of the belt before final assembly

(b) **Braces**-These are worn on the right and left part of the belt and carry fitments to receive the shoulder straps for the pack. Wearing the belt, position braces on its outside and mark the positions. Remove the belt and engage the four hooks of each brace in belt slots.

(c) **Carriers**-The carrier is worn on the left hip. Engage the hooks of the carrier in the belt eyelets at the left hip.

(d) **Pouch**-The pouch is worn on the right hip. Pass the belt through the loops of the pouch, one loop on the back part, one on the right side; reconnect right side of belt to back part.

(e) **Pack**-To fit the pack adopt the following sequence: -

(i) Slacken the buckles of both shoulder straps.

(ii) Put the shoulder straps over the shoulders and engage them in the braces.

(iii) Fasten the stub straps of the pack to the buckles on the shoulder straps.

(iv) Fasten the buckles of the pack straps to the under-arm part of the shoulder straps.

(V) Pass the two pack straps through the loops on the bottom of the packs, cross them over the front (i.e. the exposed portion of the pack when worn) of the pack and fasten them to the small buckles near the stub straps.

(vi) The personal manpack equipment is now fully assembled and ready to wear.

PACKING A PACK

The instructor should provide each member of his party with an empty pack and the necessary pack articles laid out beside it. The instructor, similarly equipped, faces his party, and demonstrates the sequence in which articles are put into the pack and where stowed therein. The rescue party then practises, supervised by the instructor. In the case of new recruits' opportunity will be taken to explain the nomenclature and purpose of each article.

ATTACHMENT OF PACKS TO INDIVIDUALS

The rescue party works in pairs in the following sequence: -

(i) "Wearer' puts on his pack engaging the shoulder straps in the braces; let the pack hang unsupported from below thus putting tension on braces and shoulder straps.

(ii) Mark the shoulder straps at the wearer's shoulders and then remove the pack.

(iii) Take shoulder strap buckles off pack stub straps.

(iv) With pack fitted and worn, fasten the first aid pouch to it. The pouch should hang snug under the pack with its sling over the top of the pack.

(v) When party manpacks are fully loaded and worn, the items carried by hand are picked up by the appropriate party numbers and the party is ready to go into action.

CARRIAGE OF EQUIPMENT (MANPACK)

3. (a) **On the Belt**

	lbs	ozs	
(i) Axe fireman's	2	4	in pouch on right side.
Cord personal 15 in.		9	hanked and suspended from press stud webbing loop on right side.
(ii) Dressing adhesive (tin)		5	in carrier on left hip.
(iii) Dressing mine (4)		5	
(iv) Goggles, dust (pair)		½	
(v) Torch, electric. 2 cells	1	0	
(vi) Gloves, debris (pair)		7	in map pocket of BD trousers or denims
(vii) Knife, clasp, with lanyard			in left breast pocket of BD blouse or denims lanyard round left shoulder
Total	3	5 ½	
(viii) Total weight of personal and manpack	3	6	webbing equipment articles
	32	2 ½	
Total	35	8 ½	

(b) In the Pack

		lbs	ozs
(i) Auger, eyed 1 in		-	11
(ii) Bands, webbing (1 long. I short)		1	10
(iii) Bar, wrecking		3	12
(iv) Blanket		4	2
(v) Band, wire			15
(vi) Chisel, 8 in. cold			14
(vii) Entrenching tool and handle		2	0
(viii) Hammer, club 2½ lb		2	12
(ix) Lashings 40 f.		2	9
(x) Pliers, side-cutting			11
(xi) Saw, general purpose with additional blade			14
	Total	**14**	**110**

(c) Slung over the Pack

		lbs	ozs
(i) First-aid pouch containing:		1	12
(ii) Bandages, triangular (4)			
(iii) Bottle water, filled			
(iv) Dressing mines (4 large)			
(v) Dressing mines (4 small)			
(vi) Labels, casualty (1 pack))		4	4
(vii) Pins, safety Q cards)			
(viii) Scissors with lanyard.			
(ix) Tourniquet, cane			
(x) Salts, smelling			1
		5	17
	Total	**26**	**15**

(d) Carried in Hand

			lbs
(i) Party leader	Nil		-
(ii) No 1 (Deputy Party leader)	Bottom half section of short extension ladder		18
(iii) No 2	Top half section of short extension ladder		13 ½
(iv) No 3	Hammer 7 lbs, sledge		7
(v) No 4	Shovel, GS Pattern		3
(vi) No 5	Shovel, GS Pattern		3
(vii) No 6	Bar, steel. 3 ft straight with chisel end		6
(vii) No 7	Bar, steel. 3 ft straight with chisel end		6
		Total	56 ½

CARRIAGE OF GROUP RESCUE EQUIPMENT

4. The equipment is divided into 8 packs with a piece of thin plywood, 13 inch square, inserted as a protection for the wearer's back, and another piece 13 inch x 5 inch inserted at the bottom of the pack in to prevent undue wear viz.:

Pack No	Contents
1.	Hydraulic rescue kit pump-2 lengths of hose-ram-adapter for ram-wedge spreader-base plate-ram toe plunger toe-groundsheet
2.	Hydraulic rescue kit pump-2 lengths of hose-ram-adapter for ram-alligator spreader-base plate-ram toe plunger toe-groundsheet
3.	Hauling and lifting machine-groundsheet.
4.	Steel wire rope and reel-handle-groundsheet
5.	Snatch block-100 ft. 2 inch rope-groundsheet.
6.	Snatch block-100 ft 2 inch rope-groundsheet.
7.	Pipe wrench stillson 14 inch-18 inch brick chisel-screw driver over 9 inch-12 inch plugging chisel-18 inch x ½ inch bull cropper-pair debris gloves-bag of nails-6 wire bonds-pair insulated gloves-groundsheet
8.	Pipe wrench stillson 14 inch-18 inch brick chisel-screw driver over 9 inch-12 inch plugging chisel-18 inch X ¼ inch bolt cropper-pair debris gloves-bag of nails-6 wire bonds-pair insulated gloves-groundsheet.

NOTE-(a) In each case the groundsheet is folded flat round the 13 inch square of plywood.
(b) The packs should be numbered 1 to 8

5. In the event of the lifting and hauling machine and the hydraulic power equipment not being available in sufficient quantities, one party in each group will be supplied with manpacks as follows:-

Pack No	Contents
1.	Screw jack (5 ton) and handle 1 sling 10 x inch steel wire rope (S W R) ground sheet
2.	Ratchet jack (5 ton) ground sheet
3.	slings 10 x inch SWR ground sheet jack handle (can be carried by hand)
4.	Pul-lift ground sheet
5. 6.	As above
7. 8.	As above

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CHAPTER 4

RELATIONSHIP WITH OTHER SERVICES

1 **Introduction**

The relationship of rescue party with the other Civil Defence Services is of utmost importance in order to understand the interlinking between these services and the rescue services. This understanding is also of vital importance during control of an incident.

FIRE SERVICE

2 The Fire Service/the Auxiliary Fire Service is always the first party to reach the scene of incident and hence get priority in deployment plus in getting initial information. The rescue party members should have a close co-operation with this service firstly due to the fact that till the fire is put off not much rescue work can progress. Secondly, in view of their firefighting work they are in better position to give details about trapped casualties. The parking of fire appliances always has to be nearest to the site and hence till the fire is put off, there is a likely possibility of the best place for keeping unloaded rescue stores not being available to the rescue party. In sorting out these problems and also to make the work at the scene of incident smooth and quick, the Incident Control Officer can play an important role.

FIRST AID PARTY

3. The first aid party becomes the next important service with which interaction of the rescue party is of utmost importance from the point of view of casualty care. The rescue party who are responsible for rescuing the casualty are also responsible for giving first aid on the spot in view of the fact that they are the first to notice the casualty. The rescue party should hand over the casualty to the first aid party at the Casualty Collection Point and also indicate to the first aid party the place of injuries the casualty has sustained plus the type of first aid treatment already given. Unlashing the casualty and placing the casualty in a resting position is the responsibility of the rescue party. The overall responsibility in ensuring the above is that of the Warden/Incident Control Officer.

WARDEN/INCIDENT CONTROL OFFICER

4. Warden/Incident Control Officer are the nucleus of all Civil Defence activities and hence the rescue party has to work in close co-operation with these officials. The entire success of Civil Defence operation depends upon the close and smooth functioning of these officials with rescue and other services. The rescue party depends upon the Warden/1.C.O. for the following information

(a) Information about trapped persons.
(b) Likely places where casualties can be found.
(c) Administration pertaining to requirement of additional equipment, manpower to welfare activity like arrangement of food at site for rescue party members.
(d) Pencil sketch of damaged building.
(e) Earmarking of places like casualty collection point, vehicle marshalling area etc.

DEPOT AND TRANSPORT SERVICE

5. The rescue party, its vehicle and equipment are housed and maintained in the depot and it is here that the party spends most of its time when not carrying out actual rescue work. The work of maintenance of equipment, vehicle and replacements if any are to be done during the rest period. Apart from this the actual work of detailing any party for a particular job after getting a message from the Control/Sub-Control Centre is that of depot superintendent through the Group Leader. It is therefore essential that every rescue party member should realise the important role that is being played by the depot and transport services in ensuring that equipment and vehicle plus the members themselves are in their peak efficiency

COMMUNICATION SERVICE

6. The part played by the communication service in passing message from the Warden to Sub Control Centre and from there to the depot and from the scene of incident to Sub-Control Centre can never be over emphasised. In fact it is the timely passing of messages on which depends the entire action of Civil Defence Operations of which rescue is a part. It is therefore a need that every rescue party member should understand the totality of the situation and the relationship that they have to maintain with all the above services.

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CHAPTER 5

BUILDING CONSTRUCTION AND APPRECIATION OF THE DAMAGE TO BUILDINGS AND UTILITIES

1. **Introduction: -**

Rescue parties during their operations, often have to search for the casualties in various collapsed portions of different types of structures. They should therefore have the basic knowledge of elementary principles of building construction, types of buildings and the manner in which they collapse due to air bombings. In addition, all types of damaged structure will contain voids or spaces in which persons may be trapped and yet may be alive. Extrication from such places will also require thorough knowledge of not only the types of buildings but also the manner of their construction. The destruction of buildings and industrial facilities by bombing will invariably result in raptured electrical water, gas, and sewer lines, other hazards will be escaping gases and chemicals used in refrigeration units and in certain industrial operations. The utilities create serious problems for casualties and rescue personnel. To ensure maximum safety to both rescue personnel must have the knowledge of the hazards involved, as well as an understanding of utility supply line pattern

TYPES OF BUILDINGS

2 Buildings can be divided into two main classes. The unframed buildings, in which the floors and roofs are supported by the walls, and the framed buildings in which the steel or the reinforced concrete frame takes all the main loads. In this latter type of buildings, the walls can be and indeed often are, added after all the floors and roofs are in position.

3 **Unframed Buildings: -**

These are buildings in which the weight of floors and roofs are carried directly on the walls below them, so that if the bomb removes the lower walls, everything above that level is likely to collapse the most familiar type of unframed building is the dwelling house. Some of the important points involved in their construction are:

(a) **Foundations**-These are the feet on which the building stands and are formed by digging shallow trenches along the lines of the walls, and partially filling them with concrete etc. to avoid it sinking.

(b) **Walls**-The outer walls are usually built of either brick or stone which are laid over-lapping one another. By this method, called "bending, the vertical joints do not run through successive courses in the wall. This gives more strength to the wall.

(c) **Roofs**-These may be of timber or concrete and these would usually be flat and be constructed to serve as floors also.

(d) **Floors**-These may be of precast concrete type or concrete laid in position reinforced with steel bars for strengthening. The precast type of floor is not likely to hold together as one slab, so well as, the "cast position" type should the walls collapse.

(e) **Services**-They comprise drains, water, gas and electricity. pipe works etc. and often have stop cocks provided in the pavement or path in front of the house so that supplies may be cut off when necessary or at the meters which are generally to be found under the stair or in cap boards in the scullery, kitchen or basement.

(f) **Basements**-They are provided to some houses, and it is desirable before entering a damaged house to look for indications of the existence of a basement.

4. **Unframed Buildings of Stone-masonry construction**: -

Where he is available in plenty foundations and walls are often constructed out of stone rather then brick Unlike the brick, the tone has irregular shape and is larger in size. Therefore, the walls in stone masonry are naturally thicker than that of brick walls

5. **Partially framed buildings: -**

There have the characteristics of both framed and unframed buildings. Usually the outer walls are of unframed sections, since they are load bearing. The framed sections are those comprising the posts or beams built in place of load bearing internal walls. This system allows more floor space Floors are either of timber or of low brick arches. Roofs may be fat or pitched.

6**. Fully-framed buildings**: -

These have a skeleton frame which carries all the loads including that of the weight of the wall. The frame may be made of steel or reinforced concrete. Each stanchion will have an individual foundation. These are of comparatively small blocks of solid concrete, large reinforced concrete or steel joints encased in concrete. When the frame is of reinforced concrete mild steel rods will be incorporated in the concrete in place of stanchions and beams Floors are laid on the beams and may be constructed of reinforced concrete. Floors are also made of precast concrete beams Roofs may be flat or partially pitched or partially flat. The walls may be erected after the Doors or roof are in position: Staircases are also usually of concrete reinforced and cast in position or formed of precast reinforced concrete steps. Such buildings are multistore hotels, offices and schools.

7. **Monolithic Buildings: -**

These are built in one piece starting from the foundations In such buildings the frame, walls, floors, staircases and roofs are formed of reinforced concrete on the site as they occur in the building as it rises.

DAMAGE TO BUILDING DUE TO CONVENTIONAL STRIKE

8. **General**:-

The major cause of damage to structures by bombing raids are because of impact of the bomb on the building, blast effect, fragmentation and earth shock.

9**. Unframed building: -**

Any bomb which strikes a building even though it fails to explode, will cause damage by the force of its impact. It will break down the adhesion between roof and walls, internal partitions and main walls, and walls and foundations. The damage caused by a heavy unexploded bomb may be great enough to lead an untrained person to believe that a small bomb has exploded. There are, however, signs which tell the experienced that a large unexploded bomb is buried in the vicinity. When a bomb explodes, the rapidly expanding gases transmit a considerable shock to the surrounding air and produce a pressure pulse which is immediately followed by a suction wave. The effect of the pressure pulse is to blow the walls inwards, the debris piling on the floors. The floors of a dwelling house are not constructed to carry tons of wreckage and so in due course, they may bend, or break across at the centre of the joints, crashing down to form the roof of two voids, the bulk of the debris falling to the lowest point. The over-loading of the ground floor may well lead to similar collapse into the basement. The suction wave is, however, the cause of most damage to buildings, external walls being sucked outwards, the bulk of the debris falling into the garden or street. The floors and roof, with some of the internal walls, are deprived of support and collapse in a heap separated only by the furniture and such portions of the walls as remain. There may be voids formed by the furniture supporting the collapsed floors. It is possible to crawl through them in comparative safety provided that such supports are not disturbed. The resistance to bomb blast of brick structures is rather poor. The floors and roofs with some of the internal walls are deprived of support due to blast effect and thus collapse in a help separated only by the furniture and such portions of the walls as may remain standing. Conventional strikes might lead to house fires. Due to the extreme heat of the fire, the wooden parts of the house are burnt and if the roof etc. are of wood, there is every likelihood of the roof collapsing if the fire persists for a while. In the case of reinforced concrete roofs, it is likely that cracks develop in the roof or floors. There is also the chance of the wall collapsing due to the heat and consequent formation of large cracks.

10 Framed buildings: -

Steel frames and reinforced concrete buildings stand up well to the blast as in both cases the skeleton frame work is rigidly knitted together. The panel walls are damaged but the roofs and floors may stay in position as they are supported by the frame work. However, parts of the frame work which bears the full force of the blast may be ripped away. Due to the light construction of the panel wall the amount of debris likely to fall is less and lighter in weight. In case of a direct hit the building. floors and roof may be damaged in addition to the wall, but the frame work may remain intact. Similarly reinforced concrete building may distort but may not collapse as the reinforcement binds the whole structure together. In case of fires the heat expands the metal frame and the first visible sign is that the skin of the concrete plaster falls off leaving the steel frame exposed. It is likely that the whole steel frame work may tilt to one side depending upon the part affected by fire.

DAMAGE TO BUILDINGS DUE TO NON-CONVENTIONAL STRIKE

11**. General: -**

The advent of the Fuel Air Explosive and atomic bomb has enormously increased the extent of damage that can be achieved by various delivery means on the cities. Both these Non-conventional weapon systems also produce effects similar to one produced by conventional High Explosive Bombs, like blast, fire and earth shock. However, the effects are of much higher intensity capable of affecting the largest building as a whole. Moreover, while framed structures may be capable of absorbing the blast effect of conventional weapons the same advantage is lost in case of nuclear strike. Major characteristic of damage to structures due to a non-conventional strike are

(a) Framed structures would suffer mass distortion and should the structure happen to be situated close to Ground Zero it may be pushed right over on its sides.

(b) The debris of unframed structures including houses would be projected away from the explosion.

(c) Total number of structures damaged would be much more as compared to conventional strike. As a rough estimate the damage from Ground Zero could be: -

(i) 0- ½ mile	-	All houses destroyed (10,000 houses)
(ii) ½ - 1 mile	-	All houses beyond repair (20,000 houses)
(iii) 1- 1 ½ miles	-	Severely damaged (35,000 houses)
(iv) 1 ½ - 2 miles	-	Slight damage (1.00.000 houses)

(The above figures are based on 20 KT bomb dropped on a large sized town).

(d) Strike may lead to a number of small fires culminating into a fire storm or conflagration.

12. **Effects: -**

(a) **Fuel Air Explosive**- Detonation of fuel rich aerosol over the projected target would produce a Squash effect over buildings due to over pressure. All structures below the aerosol depending upon the quantity of fuel would be razed to the ground and crushed, and metal framed structures would be distorted.

(b) **Atomic Strike:-**

(i) **Heat**- The intensity of heat would be such that it would ignite all readily available inflammable material fully exposed to it within about a mile and a quarter. This would lead to a number of fires culminating into conflagration and fire storms. The metallic frame would sag leading to crumbling of the roofs. In the case of concrete reinforced buildings the concrete cement mixture would get separated from joists.

(ii) **Blast**- From air burst atomic bombs, the blast in the area immediately surrounding Ground Zero acts almost vertically. Houses of normal construction are liable to he crushed and, although strongly built reinforced concrete structures may stand up to the blast pressure, their roofs will generally be damaged further away from the Ground Zero, the horizontal component of the blast wave begins to predominate. Buildings which are not blown over have their walls pushed in and are left distorted and leaning away from the Ground Zero. Iron structures are likely to be badly moulded Effect of atomic bombing in Hiroshima in 1945 close to the centre of damage can be seen in photo below.

TYPES OF COLLAPSE AND VOIDS

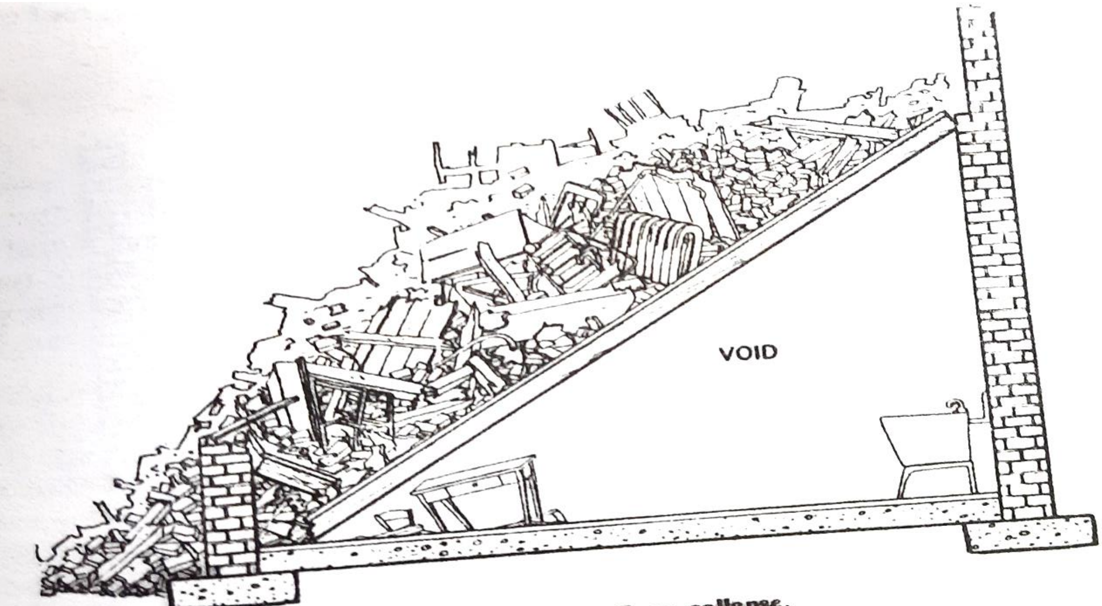
13. **Symptoms of Building Collapse**:-
The buildings before collapse develop certain signs. These are:-

(a) Cracked or drooping arches over doors, windows and other openings. are
(b) Spalling of stone work and falling of cornices, particularly on buildings with heavy facing of ornamental stone.
(c) Sagging floors or beams or gaps between the edges of floors and the walls .
(d) Displacement of steel or cast iron pillars supporting joints and beams.

14. **Types of Collapse**

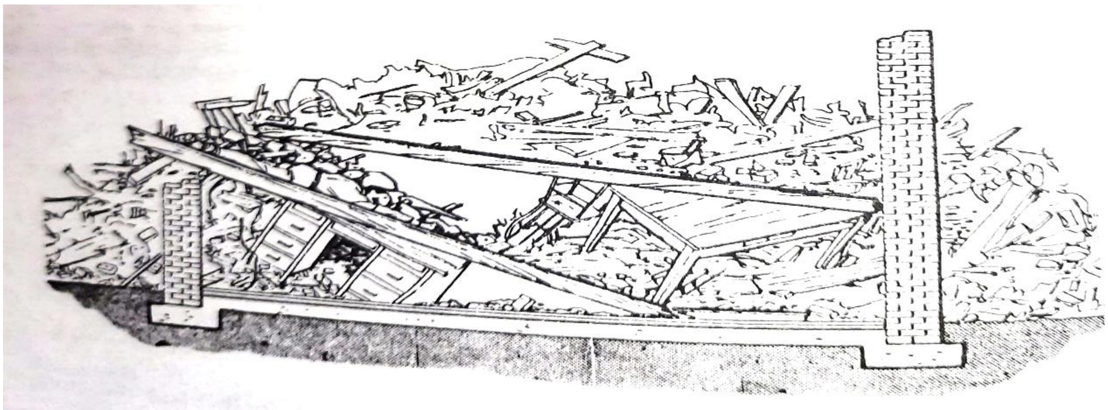
(a) **Lean to Floor Collapse-** When floor supports fall in any type of building the floors and roofs may drop in large section. These sections may form voids. In the case of lean to collapse of the floor or the roof drops on one side and hangs to the wall on the other it is termed as 'lean to type collapse. The void thus created is known as "lean to' void; and are generally larger in space and easy to reach. Such a collapse generally occurs in unframed structures.

(b) **The Hanging Collapse-** This is a variation of the lean to collapse. The only difference being that its lowest edge is not at rest and hangs free. In some cases a floor or roof section may be suspended from one of its four corners rather than along an entire edge.



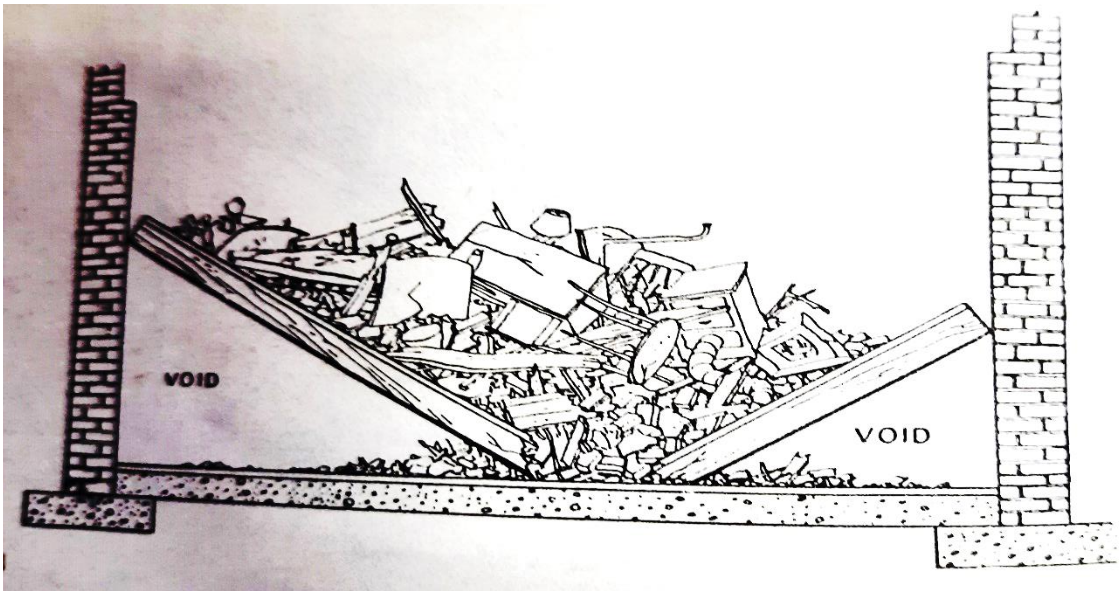
Lean to floor collapse.

(c) **Pancake Floor Collapse-**The weakening or destruction of bearing walls may cause the floors and possibly the roofs to collapse one on top of the other, into a lower floor or the basement. This is termed as pancake floor collapse: persons may be trapped between the layers of these pancakes.



Pancake floor collapse.

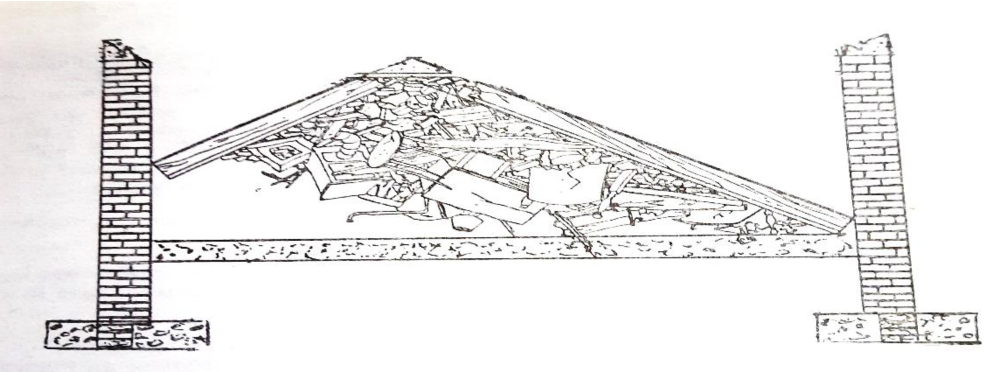
(d) **"V" Shaped Floor Collapse**-Usually floors of normal dwelling homes are not so constructed to take heavy loads. This may bend/break across at the centre of a joint span. Alternatively when as a result of the collapse the weight of heavy loads such as furniture and equipment or rubble and debris concentrates near the centre of a floor, the floor falls in the form of a V. This is known as a 'V' type of collapse-voids are formed on either side of the "V". The other cause for "V" type collapse could be when the side walls of a Gabel roof move away the roof caves in and a 'V' collapse is formed.



V-shape floor collapse.

(e) **Flat Collapse**-Occasionally when the walls spread outwards the floor or the flat roof falls straight down. The drop may be stopped by furniture or other metallic cabinets etc. and shallow voids may be formed near the bottom. The void so formed being small in size are difficult to reach and are dangerous for rescuers.

(f) **'A' Shaped Collapse**-This form of collapse is the opposite of "V shaped collapse. In this type of collapse the centre of the floor holds up and the sides collapse forming an 'A' shaped void. This can also take place when the side walls of a Gabel roof move away, the roof will cave in and a 'A' shaped collapse is formed.



"A" SHAPED FLOOR COLLAPSE

EFFECT ON UTILITIES

15. **General**:-

The destruction of buildings and industrial facilities by bombing attack will invariably result in ruptured electrical, water, gas and sewer lines. Other hazards will be escaping gases and chemicals used in refrigeration units and in certain industrial operations. These utilities create serious problems for casualties and rescue personnel. To insure maximum safety to both, rescue party must have a knowledge of the hazards involved, as well as an understanding of utility supply line patterns.

16. **Water**:-

Water released from damaged or broken water pipes, or water accumulated as a result of fire fighting activities, may cause the flooding of part of a building below ground level; and the flooding, unless checked quickly, may endanger persons trapped in the basement. Unless a damaged building is well back from the road, it will usually be found that debris has buried the stopcock box containing the stopcock controlling the supply of water to the premises and made it inaccessible. It is, therefore, important to know where the stopcock box is normally situated and what other controls may be available. Where the stopcock can be found, flooding can be prevented or stopped by turning off this cock. It will usually be situated in the footpath at the front of the premises, just inside the boundary, or in a similar position at the rear of the premises. It may be in a small hole protected by an iron hinged cover appropriately marked or by a small square of stone.

17. **Electricity**: -

Live wires present a serious hazard to trapped casualties and rescue personnel. In the great majority of bombed buildings, the electrical installation is so badly damaged that the main fuses are blown and the whole circuit rendered harmless. Care must always be taken, however, to avoid touching any cables, electrical tubing or fittings, until the supply has been definitely cut off or the installation is known to be dead. Every installation is controlled by at least one main switch When electricity is used for power as well as lighting, there may he two main switches, one for each supply. If there is more than one tenant in a building, there is sometimes a separate switch for each tenant.

18. It is an added safeguard to stand on a dry piece of timber before touching any electrical apparatus. Even after the main switch has been turned off, the cable from the switch to the road out side will still be alive. This cable is easily identified as it is usually "armoured" about 1 ½ inches or more in thickness, or is laid in a cable box or trough

19. **Domestic Gas:-**

When a building is damaged, gas pipes are usually broken and there is consequently a considerable risk of escape of gas. Gas, being highly inflammable when mixed with air, will explode violently if ignited. No lighted cigarettes or naked light of any kind must be taken near a damaged building until it is definitely known that there is no escape of domestic gas.

20 The presence of gas can generally he detected by the smell, but there is, of course, the possibility that the smell may be obscured by some other more powerful smell in the vicinity. It is important to remember that, in the event of damage to neighbouring underground gas mains, the gas may lose its characteristic smell in the act of filtering through surrounding soil, and dangerous concentrations of its deadly and odourless component (carbon monoxide) may

be met in basements, cellars or shelters in the immediate neighbourhood of the damaged gas mains,

21. It must also he remembered that the occurrence of an explosion does not necessarily mean that all the escaped or escaping gas has been burnt up.

22. The first effect of gas on human beings is to cause giddiness and loss of power in the limbs further inhalation may cause unconsciousness and death. Rescue personnel who have to work in the presence of gas must therefore use the Remote Breathing Apparatus.

23. **Sewers :-**

Broken sewers may create problems of flooding and escaping gas. Dams can be improvised to divert the flow of broken sewers away from trapped casualties and rescue working areas. Open flames should be avoided in the presence of sewer gas as it can be explosive as well as toxic. Rescue personnel should use the self-contained oxygen type mask when working in areas contaminated with sewer gas.

24. **Ammonia Fumes: -**

Many refrigeration plants contain ammonia and when damaged, liberate this gas in large quantities. Ammonia has a very strong smell and is therefore easily detected. Some slight temporary protection from this gas is given by the General Service type of respirator (which, if used for the purpose, must have the container changed as soon as possible afterwards). Unless the smell of ammonia is clearly identified (and the above precautions consequently taken) damaged refrigeration plants should always be approached from the upwind side and personnel should be protected with the remote breathing apparatus.

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CHAPTER 6

RECONNAISSANCE AND STAGES OF RESCUE

1. **Introduction**:-

Most of the Rescue Work has to be carried out under adverse conditions, such as confusion. panic, smoke, fire darkness, debris, etc. All this go to make the scene very difficult. The leader of the Rescue Party on arrival at a place of damage should quickly appreciate and form a true picture of the situation. In order to do this, he has to set about his business very systematically. This is as reconnaissance or survey. Rescue reconnaissance is in effect an attempt to arrive at an accurate assessment of the number and whereabouts of trapped casualties in order to decide the best method for their release and to categorise the stages in which the casualties are to be rescued. This is done by piecing together all available information and reports given through the damage control officer and combining them with data which can be obtained by direct observation such as:-

(a) Listening for any sounds made by a casualty.
(b) Careful observation of the manner in which the building has collapsed.
(c) Use of voids.
(d) Picking up movement of debris by electronic means.

SURVEY

Types of Survey

2. Survey is a systematic process through which accurate assessment can be arrived at as quickly as possible, so that a plan of action could be formulated. Time spent on survey can never be a waste. since it enables a quick plan of action and eliminates haphazard work and wastage of efforts. Survey can be divided into three types: -

(a) **Preliminary Survey**-The leader of the Party goes around the scene and jots down all important points, makes a quick appreciation of the situation and plans his action. Details his party to carry out rescue operation while he continues to carry on with his survey.

(b) **Detailed Survey**-During this period the leader having made a preliminary plan and encouraged by the early commencement of rescue work, goes on to detailed survey to collect more and important details. During this stage he is likely to get more information from the casualties, if they are in fit condition, his party members, the police authorities etc. This will help him to make a detailed plan so that he can employ his men and other volunteers, to get. better results, and therefore can save all the lives trapped in the damaged buildings or the debris.

(c) **Specialised Survey**-It is most likely that in majority of the cases where the damage to buildings is extensive due to natural calamities intensive air raids, the essential services such as water supply. gas and electric supply may also be damaged. In certain cases even the communications may he affected. Under such circumstances, the help of the representatives of the Essential Services who are technically qualified will be necessary, so that these damaged services can be cut off. If this is not done, the places where the trapped personnel are likely to be, may he flooded or the Essential Services thus damaged may pose a danger to the Rescue Parties.

Methods of Survey

3. In this procedure on gathering facts two important methods are used, which lead to the correct analysis of a situation and formulation of definite plans for Rescue Work. The leader should collect the following information: -

(a) The approximate nature and extent of the damage.

(b) Approaches to the place of damage.

(c) Loading points for the ambulance.

(d) Particulars of occupants of damaged buildings, or those who have been removed to safer places or those who have left the place.

(e) The probable location of those trapped inside.

(f) Whether there are any known dangers e.g. gas, electricity, water etc.

(g) Whether a doctor is present.

4. There are two distinct ways of carrying out reconnaissance. These are:

(a) **Information**-Information about the occupants of the damaged buildings may be had from the survivors, casualties who can co-operate to give information, local fire service or police and in some cases the Municipal or census registers may also be in a position to give this information. The plans of the buildings with the local architect or the Municipal engineer can be of great value to find out the type of buildings, how collapsed and therefore the likely places where people are trapped.

(b) **Observation**-Rescue Parties should be trained to understand the different types of buildings so that they can understand and analyse how a building has collapsed. This helps to make plans for extricating trapped persons. Observer can also point out the dangers arising out of damages to essential services. This helps rescuers to take precautions while carrying out rescue work. Observation along with silence and listening will help locating trapped personnel. Electronics gadgets like Trapped Person Locator (TPL) if issued to the rescue party would be of great help in locating the casualty under the debris.

STAGES OF RESCUE

5. **General:-**

No standard set of rules can be devised to give sure guidance on how to set about light rescue, but proceeding by stages, according to a simple common-sense plan, mistakes and waste of effort are more likely to be avoided. The first essential is for a leader to take charge and direct the efforts of those about him.

After assessing and planning for work, it has to be done in progressive stages, so that no casualty is left under the debris or trapped in damaged buildings. The stages of rescue are given below:

(a) **Stage I-Dealing with surface casualties-** On arrival the leader will first detail the members of his team to search for and rescue surface casualties. While the surface casualties are being attended to, the leader makes a reconnaissance of the area in which the team is to work so that he can obtain a clear picture of the nature and extent of the damage Once this is obtained he can organise the work of his team and rescue will proceed on sound lines. He will have to collect information from wardens and neighbours, make general survey of the site, note such factors as fractured gas mains, flooding, dangerous walls and other parts of the structure, and formulate a plan of action. Surface casualties will require first aid and removal to a place where warmth and shelter are available. Before they are removed one must, if they are conscious, obtain their names and addresses and any information that they are able to give. If the casualty is unconscious, a label must be tied to his clothing giving the time and place where found. All unconscious persons be treated as stretcher cases. The rescuer should try to find out who they are before they are sent to the ambulance loading point. He should give this information to his team leader. If trapped or injured casualties are found in the presence of fire, coal gas, damaged walls, or in basements which are liable to flooding from damaged water mains, an EMERGENCY RESCUE arises.

(b) **Stage II-Searching slightly damaged buildings (immediate rescue)-**Before carrying out this stage a careful examination of the damaged structure and debris is needed in order to determine the best and safest approach. The basic knowledge of building construction and forms of collapse already acquired will facilitate this.

The buildings must be thoroughly searched and the rescuer may expect to find casualties, conscious and unconscious, suffering from shock and severe cuts and bleeding caused by flying glass. Some may be lightly trapped through the sudden movement of heavy furniture and others may be choked by dust from fallen ceilings.

There is always a risk of fire owing to hot coals, etc. from open fires having been scattered by the blast. In houses where gas is used there is the danger of coal gas poisoning and explosion from:

(i) Lights, stoves, etc. having been blown out by blast.

(ii) House mains having been fractured by earth shock.

It is for this reason that rescuers must not smoke or use naked lights when searching a building.

(c) **Stage III-Exploration of likely survival points** -Having recovered all lightly trapped casualties who were seen or heard, the next step is the exploration of places where persons might be expected to be found alive, but whose exact whereabouts cannot be ascertained.

Too much stress cannot be laid on the need for searching all likely places for casualties who may still be alive and of effecting their release before any attempt is made to rescue victims who have little chance of survival. This does not mean that every nook and corner must be searched for possible casualties, but likely places must be fully explored. Typical places where the casualties may be found are:

(i) Air raid shelter, inside and outside the building.

(ii) Points near fireplaces and chimney breasts.

(iii) Spaces and cupboards under staircases.

(iv) Basements.

(v) Voids under floors that have partially collapsed.

(vi) Rooms not entirely demolished but from which exit is barred by debris.

(vii) Casualties may be found who have received severe crush injuries from fallen masonry, brickwork, beams, party walls, heavy furniture etc. These persons will be suffering from shock and their breathing passages may be clogged by the dust contained in the debris, in which case these passages must be cleared. Persons suffering from crush injuries need special treatment before release.

(d) **Stage IV-Selected debris clearance**-After Stage I to III, if persons are still missing, the search should continue until all persons are extricated and accounted for. This involves the clearing of debris at selected places where the leader presumes that casualties may be trapped. By the silence period where the casualties are called out and listened to, their position may be revealed. Such persons can only be released by clearing the debris.

(e) **Stage V-General debris clearance**-When all the possible ways of contacting the trapped personnel have failed and they have yet to be accounted for, it will become necessary that general debris clearance must be carried out by methodically cutting out lanes or tunnels leading to likely places or entrances before concluding the Rescue Operations.

MARKING OF BUILDING AFTER SEARCH

6. On concluding the survey of each building the Rescue Party should mark the buildings to show that a particular building has been searched. The leader should satisfy that all the casualties have been extricated from a building and mark a building to indicate that the building has been searched and avoids duplication of work. The objects of marking are:-

(a) To save time and labour by indicating that the building has been thoroughly searched for trapped casualties.

(b) To indicate the service responsible for the search, e.g. Warden or Rescue Section, Fire Service

(c) To indicate that the building contains some particular danger.

7. Normally only slightly damaged buildings can safely be so marked and the following standard markings must be used. A capital letter "S" chalked near the entrance will denote that the building has been searched. This will be underlined and underneath will be chalked the initial letter of the service responsible for the search, thus:-

(a) S/W = Searched by Warden Section

(b) S/F = Searched by Fire Service.

(c) S/P = Searched by Police.

(d) S/LR = Searched by those trained in Light Rescue.

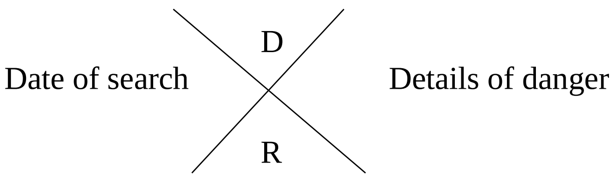
(e) S/R = Searched by Rescue Party.

8. Where searchers find dangerous conditions, e.g leaning walls, damaged staircases, holes in Boors, escaping coal gas, etc., they should chalk the letter "D" after the standard marking. Thus the symbol:-

S/WD

means that the building has been searched by Wardens and that one should look out for dangerous conditions somewhere in the building Dangerous buildings should be marked in a prominent position on all sides where entry is likely to be made. A piece of board, or some improvised barricade with the word "danger" chalked or written on it, or even string tied across an opening, will assist in warning anyone trying to enter the building.

9. Alternate method of marking a damaged building is as follows:-



The "D" indicates 'Danger and "R" denotes that the search has been carried out by Rescue Parties.

10. **"DO" and "DON'Ts" of rescue**

(a) Do keep yourself calm and cool.

(b) Do carry survey before starting rescue work

(c) Do examine casualty before removal and see that you give it the proper first aid.

(d) Do free nose and mouth of the casualty from dust and grit to facilitate breathing

(e) Do protect a casualty from falling debris and dust by using blankets, tarpaulins, corrugated iron sheets etc. if the casualty cannot be immediately removed from the site.

(f) Do be careful how you remove debris from the vicinity of a casualty.

(g) Do keep a casualty warm and so reduce shock and leave it undisturbed.

(h) Do exercise great care while using sharp tool for removal of debris.

(i) Do give plenty of water to a pinned down casualty before releasing him.

(j) Do keep as close as possible to the wall when on damaged stairs and upper floors.

(k) Do arrange for proper medical attendance of the casualty as early as possible.

(l) Don't move an injured person without rendering first-aid, unless he is in immediate danger.

(m) Don't crawl over the debris or disturb part of the damaged structures unless you are compelled to do so by circumstances.

(n) Don't touch live electric wiring.

(o) Don't pull timber out of the wreckage indiscriminately or you may cause further collapse.

RECOGNITION OF DANGEROUS STRUCTURES

11. When entering a badly damaged building care should be taken to avoid becoming a casualty. Rescuer should be able to recognise, dangerous structures. Danger from partly collapsed walls, unsafe staircases, damaged beams, etc. may confront those who enter a building immediately after it has been damaged. Rescuer should be able to take a certain amount of risk to complete a rescue operation. Unavoidable risks should be reduced to a minimum. Remember, too, that foolish risks mean extra casualties and the possible loss of one or more members of rescue team.

PRECAUTIONS ON ENTERING DAMAGED BUILDING AND OPERATING PROCEDURE

12. **General**: -

Rescue Parties may often have to enter into a damaged building for rescuing casualties who are trapped within. Safety precautions should be adopted in all such rescue work due to the fact that even the slightest vibration caused during rescue work or a careless step by any member, may cause further collapse of the damaged building. Rescue work will be hampered and as a result many lives, which would otherwise have been saved, would perish.

PRECAUTIONS TO BE OBSERVED

13. The precautions to be observed by Rescue members can conveniently be placed into three phases, as follows:

(a**) Phase I- Precautions before entering a damaged building**.

(i) Observe the construction of the building and how it has collapsed. Check up which is in a precarious condition and then enter the building.

(ii) Check-up whether the walls or floor requires any support before extricating the casualties.

(iii) Be on the alert for any utility hazards e.g. live electric wires etc.

(b) Phase II. Precautions on entering a damaged building.

(i) Always wear a helmet

(ii) Work in pairs if possible.

(iii) Listen to possible sounds from casualties.

(iv) Keep calling

(v) Don't touch any damaged wall or blocked door or any such structure, which is broken and projecting.

(vi) Do not disturb any broken glass panes or door panes.

(vi) Treat all naked wires as live wires and do not touch them with naked hands.

(c) Phase III. Precautions while moving inside damaged building.

(i) Do not strike a match or smoke

(ii) Smell for any existence of gas etc.

(iii) Always walk as close to the wall as possible when on damaged staircase or upper floors.

(iv) Keep off debris as much as you can lest the natural voids may be destroyed by further collapse .

(v) Avoid indiscriminate and careless movement over the debris or on collapsed parts of the building

(vi) Do not pull any timber parts out of the wreckage indiscriminately, as this will cause further collapse.

(vii) Use of guide line when entering dark and dangerous or smoky places.

(viii) Obey all instructions implicitly.

OPERATING PROCEDURE

14 (a) **Debris clearance**-The debris clearance may be necessary when no information is available as to the approximate position of the trapped persons. General debris clearance (stage 5 of the Rescue) will have to be done. Sometimes, debris may have to be removed to clear a road block at the site of damage. Such debris clearance could be undertaken at leisure and the mechanical means can be used for this purpose. Whenever there is a reasonable chance of recovering casualties, the debris clearance should be carried out by Rescue Parties. The debris should, if possible, be moved clear of the damaged building and not merely from one part of the site to another. Whenever it is possible, the general clearance of the debris to make a path for lorries etc, and rescue operations should be carried out simultaneously. The Incident Officer should try to get the assistance of the public for this purpose as far as possible. The debris can be removed by loading into baskets by hand and man-handling the same to the vehicle or a selected spot and where the debris is to be dumped. When removing debris in a confined place or over obstacles, it is best to form a human chain. Debris should not be dumped near fire hydrants as fire engines may have to be brought there. The dumping sites of the debris must be indicated to the Incident Officer. Some of the precautions to be observed during debris clearance are:-

(i) Great care must be exercised in the use of tools, especially picks, to avoid injury to the casualty under the debris.

(ii) Debris in the immediate vicinity of the casualty should be removed by hand.

(iii) Rescue Parties, unless efficiently controlled, may degenerate into a disorganised crowd of men, picking here and digging there, without any set plan of action. Therefore, the leader must map out his work.

(iv) Men must not climb about on top of a pile of debris during the clearing operations unless it becomes absolutely essential.

(v) Timber should only be withdrawn from debris where it is certain that no further collapse will be caused.

(vi) When the debris clearance operations are prolonged, it is essential to ensure continuity of work from shift to shift and therefore all necessary information must be passed from leader to leader.

(vii) Where it is essential to clear debris from the top downwards, men should be stationed in such a position that they can pass timbers and other pieces of debris to one another without having to climb over the debris.

(viii) The leader should allocate sections of the work to specified men and see that each man gets on with and sticks to his own particular job.

(ix) Debris should not be dumped into a crater

(x) Avoid the use of mechanical grabs and other machinery when clearing debris from sites where people are still trapped, though cranes can usefully be brought into action for the removal of heavy materials such as blocks of masonry, concrete and steel-work.

(xi) Speed is unquestionably a most important factor in all stages of rescue operations, but speed without safety to both the rescuer and victims may quite easily defeat its own ends. The ideal is speed with safety.

(b) Building search

(i) **Search of building on fire**

(aa) Ascertain from neighbours whether there is anyone still in the burning house, if so, the probable number.

(ab) If possible work in pairs.

(ac) Start searching from the top of the building, so that you may be nearer the fresh air at the end of your job.

(ad) Search swiftly but thoroughly. Do not overlook any possible hiding place. People trapped by fire or smoke, particularly children, often take cover under beds or in cup boards to escape the smoke and flames.

(c) **Search of smoke filled room**

(aa) Do not throw open the door of the room suddenly. The heated gas and smoke, inside may overwhelm you.

(ab) Open the door slowly with yourself in a crouching position. This will allow the hot gases and smoke to pass over your head.

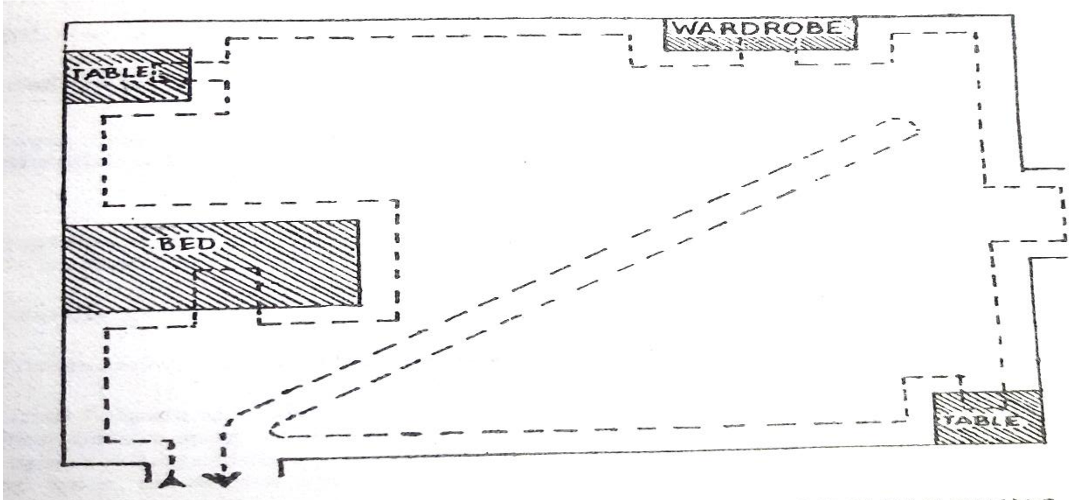


DIAGRAM SHOWING CORRECT METHOD OF SEARCHING A ROOM (ac) In case the door of the room opens outwards place one foot against the bottom of the door and open gently. This will protect you from injury from sudden outwards swing of the door as a result of considerable pressure on it due to the expansion of the heated gases inside the room.

(ad) Enter the room in a crawling position as there is less smoke and less hot air near the floor. This enables you to breathe comparatively fresh air and see things in the room clearer.

(ae) Always move in a crawling posture while inside the room.

(af) Keep yourself also to the wall while moving.

(ag) Make a complete circuit in the room.

(ah) Feel under and on the beds.

(ai) Open and feel inside cupboards, wardrobes and other likely places of hiding.
(aj) Cross the room diagonally to make sure that no one is lying in the middle.

(d) **Calling and listening for trapped persons-**When it is known that persons are still missing and in cases where a rescuer is confronted with a major collapse of premises which may resemble a heap of rubble, bricks, etc., a calling and listening period should be introduced. This has in the past saved many lives and is carried out in the following manner:

The leader places his men at suitable vantage points around the area in which persons may he trapped. He then demands complete silence and each member of the team in rotation calls "Is anyone there-can you hear me?" The other members of the team listen intently for any reply. If none is heard it is a good plan to tap on a wall, or on any gas or water pipe, beam, etc., running into the debris, all of which are good conductors of sound, and again listen for an answer.

Once communication of this kind has been established with a trapped person, it should as far as possible be continually maintained because:

(aa) It keeps up his morale, it helps him to withstand whatever pain and discomfort he may be suffering, and may even keep him alive.

(ab) It helps the rescuer to work in the right direction, often a difficult matter, particularly in the dark.

(ac) The victim, if conscious, may be able to give warning of any movement in the debris likely to cause him further injury.

(e**) Removal of a casualty from electric contact**-It is very dangerous to touch a person who is in contact with a live electric wire without taking proper precautions. Take the following precautions before you touch such a person:

(i) Switch off the current before you touch the casualty.

(ii) Stand on a dry wooden piece or on any article which is non-conductor of electricity, such as a thick pud of dry newspaper, mackintosh coat or sheet and other things of like nature.

(iii) Protect the hands with some form of insulating materials such as rubber gloves, a mackintosh coat or sheet or some dry woollen material.

(iv) Remove the casualty from the wire or apparatus or push or pull the wire, electrical apparatus from the person with a dry stick.

(f) Precautions against public utility-Searchers in damaged buildings should turn off gas, water and electricity services at the main. They should make themselves acquainted with the "local" positions of stop taps and mains. Where casualties are in danger from damaged services and the main stop taps or switches are not accessible the following temporary measures may be adopted:

(i) **Gas**-If the pipe is made of lead, the ends should be hammered flat. A piece of clay or something similar will temporarily stop a leak.

(ii) **Water**-If water is pouring from the end of a broken iron pipe, a wooden plug can be driven in to stop the flow, but the success of this will depend on the pressure of the water. If the leakage is due to a split in the pipe, a piece of clay over the split and kept in place with sacking or old cloth will help to stop the flow. If the leak is from the broken end of a small lead or copper service pipe, this should be hammered flat, the flattened end bent back and hammered on to itself

(iii) **Electric wiring**-If the fuses cannot be found and taken out, any dry non-conductive material such as a broom handle, dry piece of wood, rubber hose, etc, may be used to remove live wires from the casualty.

15. **Conclusion**-Always observe the following safety precautions when searching damaged premises: -

(a) Wear a steel or protective helmet if one is available.

(b) Do not enter dangerous places without informing some member of the team. If possible, take a companion to help in case of accident.

(c) Do not smoke or strike matches in case coal gas is present, and always be on the alert for the smell of escaping gas.

(d) Avoid touching loose electric wires.

(e) Walk as close as possible to the wall when on damaged floors or stairs.

(f) Disturb debris as little as possible to avoid collapse.

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CHAPTER 7

RESCUE TOOLS AND USES

1. **Introduction**:-

Rescue workers may have to cut through heavy wood, iron beams and steel girders or force openings in masonry walls and concrete floors, for this the rescuers may have to use tools which may be carried by them in the rescue vehicle or may have to be provided from outside agencies.

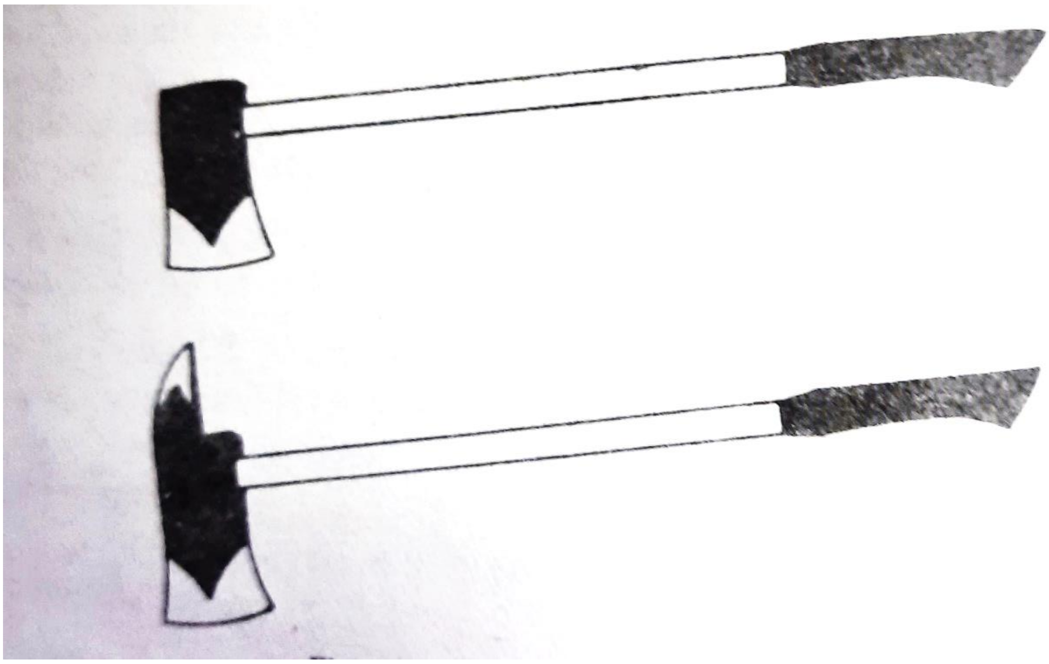
2. Forcible entry to a rescuer implies obtaining entrance through locked or secured doors and windows and the openings of tools, floors, skylight, partition and walls by mechanical means to reach to the spot where trapped persons may be located. The knowledge of these tools and their use in emergency entry must, therefore, be known to all rescuers.

RESCUE TOOLS

3**. Tools carried by Rescue Party**:-

The following small tools are generally used by rescue party:

(a) **Axe**- Axes both flat-headed and pick-headed, are probably the tools most often used in res cue. They can be used for cutting, prying and striking. They should be kept sharp, ready for instant use. It is best if the handles are maintained in a smooth condition and treated with boiled linseed oil or other wood conditioner, because painted handles have a tendency to blister the workers' hands during prolonged usage.



Flat and Thick Headed Axe

There are three kind of axes issued to the rescue service:

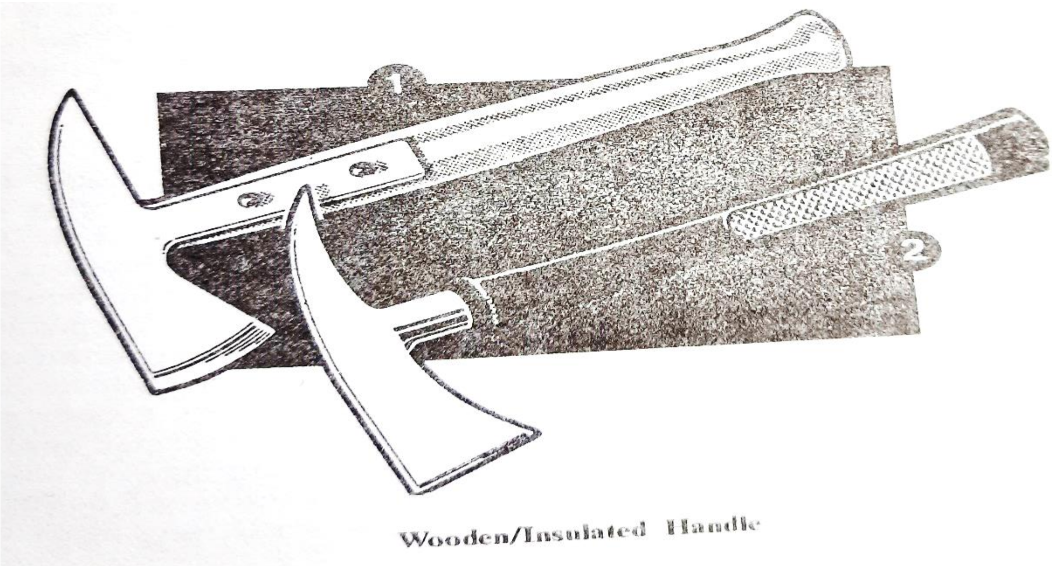
(i) **The Heavy Axe**-The heavy axe has a five inch cutting edge and the shaft is three feet in length.

(ii) **The Light Axe**-The light axe has a little smaller head than the heavy and the cutting edge is from three to about four and half inches, whilst the shaft is one foot in length. The former is used for smashing through heavy doors, floors, etc. and for cutting down struts where there is room to swing the axe, and the latter is used for cutting through small timbers or for use in confined spaces.

(iii) **The Fireman's Axe**-The fire man's axe has a two inch cutting edge on one side and a point on the other, the shaft is very often insulated, but generally it is of ash and about twelve inches in length. The axe is used for cutting through door panels. windows etc. and for use in confined spaces. The pointed end is used for pulling apart burning of smouldering material so that water may be sprayed on it. The fireman's axe is normally a part of every fireman's personal gear, together with his belt and axe-pouch, but it is also carried in hook used with hook and turntable ladders. There are two types in general use. One having a wooden handle and the other an insulated steel handle:

(aa) **Wooden Handle**-This axe is specially hardened steel, polished and treated with clear lacquer or other such finish as may be required by the purchaser, is used for the axe head. The handle is made from well-seasoned best straight grained ash with a natural sanded finish. The overall length is about 15 ins (380 mm) and the axe weights between 2 and 2 ¼ lb (907 to 1134g). The handle is fitted right through the head and two countersunk head rivets secure the head straps to the handle. The wooden-handled axe provides no protection to the user against injury by electric shock other than the limited insulation properties of the wooden handle.

(ab) **Insulated Handle-Insulated**-handled axe is not intended as a piece of special equipment which will permit personnel deliberately to operate on live electrical circuits, but that it should be regarded as a tool that could give an added degree of safety in circumstances where a live electrical circuit may be accidentally touched. The fact that the handle of the axe is covered with an insulant is not in itself a guarantee that the user is safe from electric shock, and therefore, additional safeguards must be observed when work is carried out on electrical equipment, particularly in view of the fact that the axe may often be used in wet conditions. The axe head complete with tang is made from specially hardened steel and the handle is made of black rubber, which is moulded to the steel tang. The dimensions and weight are about the same as for the ash-handled axe. Each axe that has passed the electrical test has 1 inch (25 mm) wide blue rubber hand secured to the insulated handle between the chequered grip and the head, and this band should bear the date of test. The insulation should not he unnecessarily exposed to heat or allowed to come into contact with oil, grease, turpentine, motor spirit or acid. When the insulation becomes soiled, it should be thoroughly washed with soap and water, and dried. If it should become contaminated with tar or paint, it can be wiped clean with a suitable solvent which is not injurious to rubber. and then immediately washed and treated as above. Petrol or paraffin should not be used for removing such compounds.



(b) **Saws**

(i) **Handsaw**- The handsaw is used extensively during rescue operations for cutting through floor joists, pieces of furniture, and to cut the timbers required for shoring in debris etc. It varies in size from the smaller pruning saw to the carpenters saw, which although there are many sizes, is usually two feet six inches in length, and tapers from six inches at the handle to about two inches at the end of the blade. The blade is of fine quality steel and the cutting edge is a series of teeth, set at about 8 to 10 to the inch, which must be kept set and sharp.

(ii**) Pruning Saw**-The pruning saw is about 9 inches in length and has teeth on each edge of the blade, it has proved of great value where persons have been trapped in a confined space.

(iii) **Crosscut Saw**-The crosscut saw is double handled so that two men can operate it, its length is approximately five feet and it is usually from four to eight inches wide. The teeth of a crosscut saw are much larger than those of the handsaw, and are not in pairs with a space in between each pair. It is used for cutting through bulk timbers. The cutting stroke of a saw is the one against the point of the teeth, or the sharpened edge of the teeth. In the case of the crosscut saw the teeth are sharpened on either side, so that the saw will cut in both directions.

(iv) **Hack Saw**-The saw used for cutting through small pipes and piece of steel and iron is the hack saw. It has detachable blade which vary in length from eight to twelve inches and are usually half an inch in width. They are obtainable in special forms according to the type of metal to be cut, and each has a hole at the ends. The frame is of steel and is supplied in two types, the adjustable and the non-adjustable. The blade is attached to pins at each end of the frame and is tightened by a wing nut and screw.

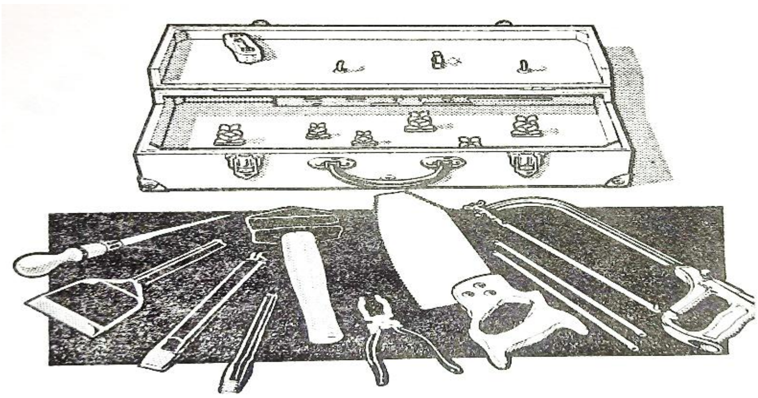
(c) **Picks**-The pick is a double ended tool made of steel, both ends being pointed, some picks have a one inch cutting edge on end and the shaft is three feet in length. The pick is used for loosening compact earth or debris. Great care must be taken when using it to turn over debris. Do not drive the point deep into the debris, casualties may sustain very severe injury through careless use of this tool. It should only be used for loosening the top layer of debris when victims are suspected underneath.

(d) **Shovels**-The shovel is a tool which is supplied in many sizes and shapes. The type usually issued to the Rescue Service is known as the builders' shovel. The handle is about three feet in length, and the blade is roughly twelve inches wide and fourteen inches deep. It is a very useful tool to use when clearing a bombed site, provided the user can find a level bottom. It cannot however be used as a digging tool. In some cases the builders shovel is too large to use in debris, and where it is necessary to burrow into the centre of debris it is almost useless. The best and most useful type of shovel for this kind of work has from experience been found to be the domestic coal shovel, which is of steel and is made in one piece. It is about four inches wide and nine inches deep. For removing dust and small rubble in confined spaces or when working close to a casualty, a small fireside shovel is best.

(e) **Ceiling Hook**-The ceiling hook consists of a pole of 7 to 8 fts (2.1 to 2.4 m) long having at the top a steel point with a spur at right angles, the point and spur each being about 4 inches (102 mm) long. This tool is of interest as being one of the few items of small gear which were primarily developed for fire brigade use. Its relationship to a boat-hook is, of course, obvious, but in its present form it is exclusively a fire brigade tool. The ceiling hook is now commonly used to pierce a ceiling to allow water to escape and this prevent the possible collapse of the ceiling itself due to the weight of water. The spur is used for pulling down ceilings which have partially fallen and are in a dangerous condition. The hook is driven up through the ceiling and the spur is twisted until a grip is obtained on any projecting laths. A sharp pull will then bring down a portion of the laths and plaster; the operation is then repeated until the ceiling is considered safe. The same procedure may also be followed for pulling lath and plaster walls The ceiling hook is a general purpose tool which is frequently used during turning-over and pulling-down operations and for any job which calls for a long reach with a rigid piece of equipment.

(f) **Heart Kit**- The hearth kit as shown below and which is generally carried by the fireman, can also be used by the rescue. It consists of :-

(i) Bricklayer's bolster.
(ii) Two cold chisels.
(iii) Club hammer.
(iv) Insulated plier.
(v) Floorboard saw.
(vi) Hacksaw.
(vii) Spare hacksaw blades.
(viii) Screwdriver.

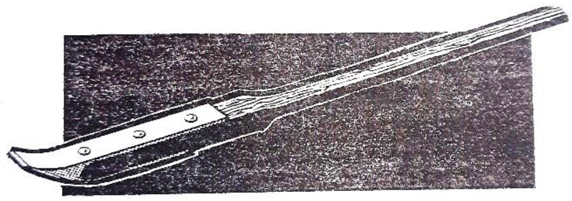


Heart Kit

(g) **Canvas Buckets-** Canvas buckets of capacities varying from (9-18 litres) are carried for general purpose usage. They can be folded or rolled, and occupy only a small amount of locker space. Before being stowed, canvas buckets should be thoroughly dried to prevent the formation of mildew; in short, their care and maintenance should generally be the same as for canvas hose.

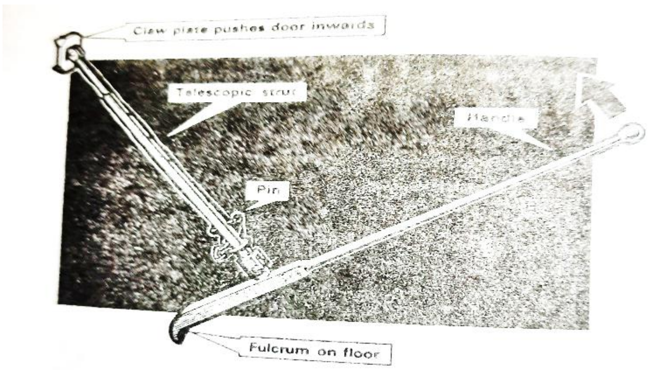
(h) **Crowbars-**Crowbars of various types form an essential part of the equipment of rescuers. The most common type consists of a steel bar about 3 ft (914 mm) in length, either one or both ends of which are shaped at an angle to provide leverage. One end is usually claw shaped for use when levering out nails, screws and the other fittings, whilst the other end is chisel-shaped. Crowbars are used to provide the necessary leverage to facilitate the forcing of doors and windows and the removal of fittings and objects which may be found to impede fire fighting or rescue operations.

(j) **The Steel-shod Lever-**The steel-shod lever consists of a straight wooden shaft, usually of seasoned ash, about 2 ins (50mm) diameter, increasing to about 3 ins (76 mm) in square section at one end, to which is riveted a heavy iron shoe with a slightly upturned chisel-shaped tip. The steel-shod lever is used for breaking open steel doors and other obstructions, the tip being inserted under the door and leverage exerted. It is also used for lifting blocks of stone or concrete, heavy baulks of timber and material when turning over.



Steel Shod Lever

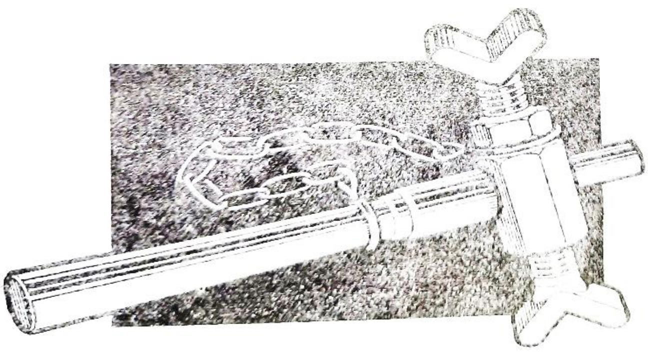
(k**)** **Door breaker-** Door breakers are sometimes used by rescuers and several different types of proprietary tool are obtainable. They will work by the application in one way or another of the lever principle. It consists of a steel lever to which is attached, by means of a pivot, a telescopic strut which terminates in a pivoted claw plate. Application of upward pressure to the lever handle exerts sufficient force on the claw plate either to break in a panel or to force a door open.



(1) **Padlock Remover**-Some form of special lever or other tool, often of local design and construction, is frequently to be found amongst the equipment on fire appliances to facilitate the rapid removal of padlocks. One example of this type of tool is illustrated. The padlock being inserted in one of the two openings in the tool whilst the other end is used to give sufficient leverage to force the lock or hasp. When no special tool are available, many padlocks can easily be forced by wedging the hasp against the door with the hinge downwards and giving the body of the lock a sharp blow with a hammer, axe or other suitable tool.

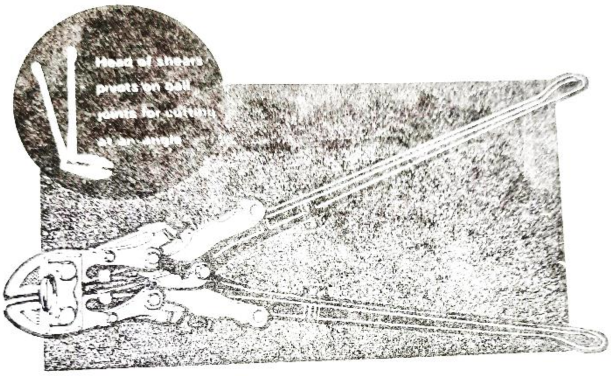
(m) **Persuader**-Persuader is a term commonly used to describe a tool consisting of a cigar-shaped cold chisel to which a steel handle is secured and it is normally used for forcing padlocks which cannot be dealt with by the use of padlock removers, crowbars or other available tools. The point of the chisel is blunt since the function of the tool is not to cut but to break a padlock by the expanding effect of the tapered chisel being forced into the loop of the hasp by blows from a heavy hammer.

(n) **Railing Spreader**-Spreaders, or expanding tools, of various kinds are used for forcing apart iron bars, such as railings, usually to facilitate the release of trapped persons or animals. One type of railing spreader in current use which consists of a nut threaded internally to receive two "V shaped lugs with threaded stems. A handle in the form of a tommy bar fits into a hole bored through the sides of the nut. The "V-shaped lugs are placed against the bars to be moved, and when the nut is rotated by means of the bar, the lugs are forced out wards, thus forcing the bars apart.



(0) **Bending Bar**-Bending bars, or wring-irons as they are sometimes called, are used for bending metal rods, bars or sheeting which impede rescue. Many different types and sizes of bending bar are used, but they all apply the principle of leverage in one way or another to produce the desired results. It consists of a solid steel handle about 4 ft (1.2 m) in length terminating in a plate which carries two solid lugs both about 2 ins (50 mm) long. The lugs are

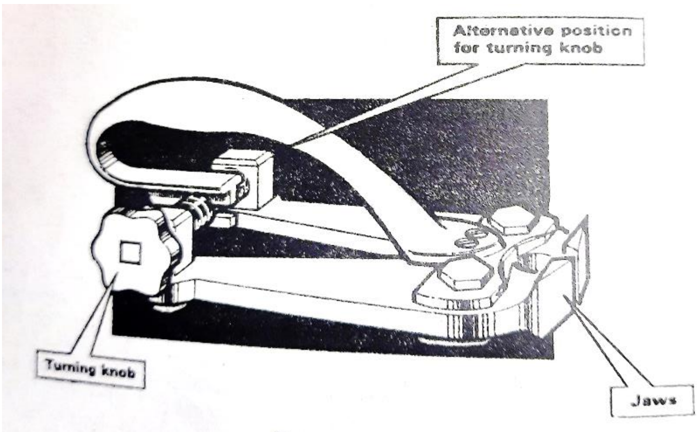
placed one on each side of the object to be bent and leverage is applied by means of the handle so that one lug holds the object secure while the other bends it.



Cutter

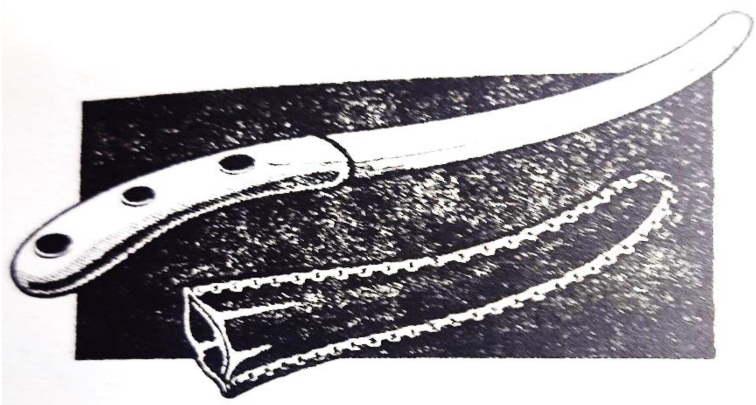
(p) **Cutter**-Cutters of various types are used for cutting metal bolts and padlock hasps to facilitate entry into warehouses and other premises which are protected by heavily bolted doors. They are also used in circumstances where metal obstacles impede rescue operation The jaws are operated on a double fulcrum and sometimes have semi-circular slots in each blade to enable the tool to be used as bolt cutters. The handles are pivoted on ball joints so that when necessary the head can be used at right angles to the handles

(q) **Bolt Cutter**-Various types of purpose-made tool are used for cutting bolts and padlock hasps, a typical example of one being illustrated. With this type of bolt cutter the action of the jaws is controlled by a threaded attachment which is hand-operated by the turning of a knob.



Bolt Cutter

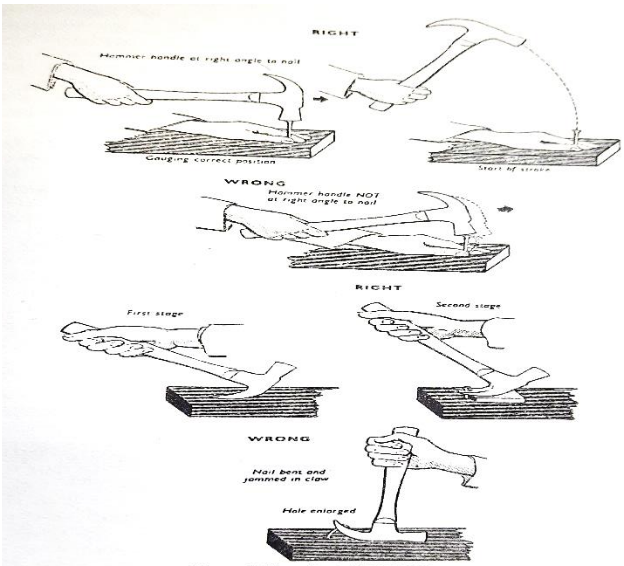
(r) **Quick Release Knife**-A special type of knife, known as a quick-release knife is sometimes carried on appliances for use in emergencies to facilitate the speedy release of persons trapped by harness, belts or straps, such as, for example, persons trapped in belted machinery. The cutting edge of the slightly curved blade should be kept very sharp. whereas the outer edge and tip are thick with a smooth rounded finish. This design enables the knife to be used speedily without fear of cutting the casualty, by inserting it inside the belt or strap with the blunt edge against the person's body.



Quick release Knife

(s) **Cold Set-** A cold set is a blacksmith's tool used for cutting metal bars without first heating them. and is carried on some emergency tenders. It consists of a short specially hardened form of cold chisel secured in a metal handle which is held by one man whilst another strikes the chisel head with a sledgehammer.

(t) **Claw Hammer-** This hammer is used in general carpentry work for driving and extracting nails. The hammer handle should be at right angles to the nail at the moment of impact, otherwise the nail will be driven sideways, this can be achieved if a wrist action is used and the forearm is held steady after gauging the correct position for the hammer. Similarly, when extracting a nail the pull should be along the length of the nail; this can be done by using a chock under the hammer as the nail is withdrawn.



Use of the claw hammer

4. **Tools available with Other Agencies**.

(a) **Power Saws**- There are several different types of gasoline-powered saws that are extremely valuable for forcible entry, rescue and ventilation work. Rescue saws are powered with two cycle gasoline engines; they are very portable, and various types of carbide-tipped blades and abrasive discs can be obtained to cut practically every type of material. These saws can do a tremendous amount of work in a very short period of time when used properly. But they can be unsafe and dangerous unless precautions are taken; since they have cutting blades of 12 or 14 inches in diameter, these tools should be used with caution. When using any type of saw, observe the "buddy system", one person concentrates on operating the saw while the other, the buddy, stands by to warn of imminent hazards, such as high-tension wires, unstable footing, or any other condition that might be a safety hazard. Both users should wear full protective clothing, including safety goggles. A common mistake in using a rotary rescue saw is the failure to maintain normal blade speed. Allow the blade to feed into the work only as fast as the material is cut. Forcing the blade into the work in a vain effort to expedite the cutting process only lugs the engine, slows down the blade speed, and reduces the cutting effectiveness; in addition, it increases the danger of breaking the abrasive discs. To avoid binding the blade, cut in a straight line. A wavy kerf indicates a failure to hold the saw steady and the blade intermittently binds and slows down; this decreases the cutting speed and increases the danger of breaking the blade or abrasive disc. Binding can be avoided by holding the saw steady, starting a cut slowly and then letting the saw find its own path. When cutting ferrous metal, the abrasive disc throws out a heavy stream of sparks Therefore, an extinguisher or a charged hose line should be ready whenever there are combustibles or flammable liquids in the area. If the saw is being used to extricate a victim from automobile wreckage, cover the period with blanket or sheet for protection from the shower of sparks. If there is a choice, cut in the direction that will keep the flow of sparks away from both the victim and the flammables. When opening up a roof, remove the tar paper and stones from the area in which the cut is to be made in order to prevent the tar from gumming up the blade; rocks can attain a tremendous velocity when hit by the disc. Never stand in line with the blade unless protected by a guard. Pieces of the blades develop high speeds when they disintegrate. Test run a new blade at high speed before cutting to be sure it is safe. Always start a new cut if blades are changed, as the old cut may be too narrow for the new blade; this will cause it to bind and it may shatter or kick.

(b**) Chain Saw**- Chain saws are extremely valuable in providing sources of ventilation in burning buildings; openings should be made through the roofs and walls. These saws are capable of making much deeper cuts because their blades are longer than those of other saws. To reduce the risk of electrocution when cutting into a structure, always wear rubber electrician's gloves under the regular gloves; electrical wires could accidentally be cut into when making blind cuts. A carbide-tipped chain that will cut brick, masonry, soft metals and tar and gravel roofs with little trouble. These chains do not necessitate the frequent resharpening of the teeth that conventional chains require.

(c) **Lifting Equipment**- A considerable variety of different types of lifting equipment is used and includes hydraulic jacks of various kinds and sizes, air lifting bags, portable winches, chain blocks and tackle, sheer legs etc.

(d) **Heavy Mechanical Plants.**

(i) **General-** In the last war it was found that at major incidents the use of heavy mechanical plant was frequently necessary in support of rescue operations. Such equipment was used to help in the quick removal of debris: to lift heavy blocks of brickwork or masonry: to take the weight of collapsed floors and girders so that voids could be explored and casualties extricated; to haul off twisted steelwork and other debris and to break up sections of reinforced concrete. In future all these tasks may be required and heavy clearance may have to be effected to enable rescue and other Civil Defence vehicles to approach within reasonable distance of their tasks. The problem of debris will in fact be a major factor in Civil Defence operations.

(ii) **Requirements**-Heavy mechanical plant may be required for the following purposes:

(aa) To assist in the removal of persons injured or trapped. At this stage mainly heavy plant is needed, particularly mobile cranes with sufficient length of boom or jib to reach for long distances over the wreckage of buildings.

(ab) To force a passage for Civil Defence vehicles and fire appliances to enable them to reach areas where major rescue and other problems exist and require urgent operational action.

(ac) To take certain safety measures eg to pull down unsafe structures.

(ad) To clear streets and pavement to help restore communication and to afford access for the repair of damaged mains and pips beneath the streets.

(ae) For the final clearance of debris and the tidying of sits. this is a long term and not an operational requirement.

(iii) **Urgent Rescue Operations** - During rescue operation in London in the last war the machine used with great success included heavy 3 ½ -5 ton mobile cranes, mounted on road wheels with a 30-40 ft jib: medium heavy 2- 3 ½ ton mobile cranes mounted on road wheels, with a 26 ft jib; heavy crawler tractor bulldozers: medium crawler tractor bulldozers; mechanical shovels and compressors, three stage mounted on road wheels. In the case of a large or multiple incident where access was obstructed by considerable quantities of scattered debris, a bulldozer or tractor was first employed in order to clear one or more approaches by which other equipment and personnel could reach the scene of operations. Next all debris of manhandling size was loaded into one-yard skips and discharged by the crane into lorries, giving increased manoeuvring space to the Services operating on the site. Heavy mobile cranes were then brought up to the incident where used under the skilled direction of the rescue party Leader, they were invaluable for removing girders and large blocks of masonry which obstructed access to casualties or persons trapped. The necessary chains and wire ropes for these operations formed part of the standard equipment of the heavy and medium-heavy mobile cranes. The work was, of course, carried out in close co-operation with the Rescue Parties who also used various forms of light mechanical equipment, such as jacks and ratchet lifting tackle for work in confined spaces. Compressors sometimes proved valuable for breaking up large masonry such as falled walls, into sections of a size and weight within the handling and lifting capacity of the cranes. This method was only used when it was known that there were no casualties under the masonry. Mobile cranes and other heavy mechanical plant were withdrawn as soon as all casualties had been removed to be available for use at other incidents. Heavy debris clearance equipment of the following types were used before-excavators, crawler tractor mounted as forward shovel, $^{3}/_{8}$ to $^{5}/_{8}$ cubic yard size; mobile cranes, 3-ton type, with 1-yard skip buckets, crawler tractor bulldozers; compressors on road wheels, 3-tool type vehicles for debris transport (tipping steam wagons, 3-ton Upping lorries and dumpers). The forward shovel excavator would be used for loading loose debris direct into lorries at street level or on site, to which the excavator could get direct access. Its advantages for this purpose were speed of operation and the elimination of hand. labour for the filling of skips. For positions within a building, such as basements or floors above or blow street level, clearance could only be effected by the use of mobile cranes where length of jib was of great advantage. Skips were loaded at the inaccessible point, picked up by crane and discharged direct into the waiting lorries. Steam wagons were invaluable for pulling down unsafe walls, chimney stacks and similar wreckage. In some cases the bulldozer was used for this purpose, though the main activity of this machine lay in pushing up debris into heaps at suitable points on site for loading by the shovel excavator or crane and skips. The special advantage of the steam wagon when used in pulling down dangerous walls was due to the greater flexibility of steam power whereby a very slow and steady pull could be smoothly attained. In this phase, again, a compressor proved valuable, for breaking down large blocks of masonry to a size suitable for lifting by crane. A 2-ton drop weight attached to the jib of a mobile crane or excavator was also used for breaking large masonry, and particularly for pounding fallen walls, a task which it completed in much less time that the compressor.

(e) **Clearance of Streets and Pavements**- The importance and urgency of operations to clear streets and pavements lies in the fact that, until performed, the life of the community in terms of traffic, communications, water supply, sewers, gas and so on, cannot be restored. Except for the distinction that the operations in this phase are carried out upon level hard paved accessible surfaces such as roads and pavements, the operation and plant generally is similar to that used in the preceding phase. Mobile cranes can also be employed on clearance work when not required for more urgent rescue operations.

(f) **Use of Steel Cables and Hauling Gear in Demolition**- In many incidents it was found that the explosion had so disrupted buildings that many parts, walls, chimneys, stanchions and floors were cut off or left in a state of great instability, with likelihood of possible further collapse, risk to life and damage to adjacent property. These conditions called for prompt and skilled action, involving the controlled direction of the fall of these unsafe parts, by the use of slowly applied power exerted through wire cables.

HYDRAULIC POWER EQUIPMENT

5. **General**- The use of hydraulic power for pumps, rams and numerous lifting appliances has been recognised for many years as being highly efficient and adaptable, and now that portability of rescue equipment has become an important factor, the application of this principle, especially with easily handled transportable equipment, is of the utmost importance in rescue work. Many life-saving tasks will involve raising heavy loads, prising up collapsed floors to enable entry to be gained, and forcing apart masses of concrete, brickwork or other debris, to facilitate access to casualties trapped within voids. Any equipment used for this work must therefore, be portable, sufficiently powerful, and capable of being utilised quickly and efficiently.

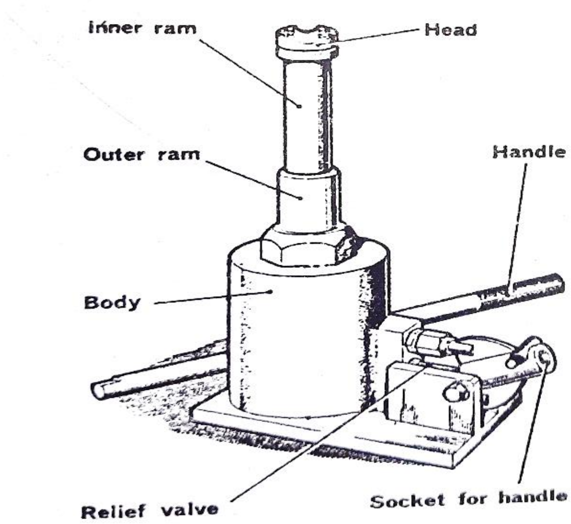
6. **Hydraulic Rescue Set-** A remote controlled hydraulic jack has been developed that will greatly simplify and speed up many rescue operations. This jack consists of a hydraulic unit with a pump (source of power) separated from the ram (power end) by a section of long flexible hose. A wide range of rams and attachments provides countless combinations for pushing, pulling, lifting pressing bending, spreading and clamping. The ram end can be used in any position. The jacks vary in size from a 4-ton (3.6 metric tons) light duty set to a powerful 50-ton (45 metric tons) unit. The light duty unit is ideal for removal of trapped victims from automobile wrecks, for forcible entry into buildings, and for similar situations where casualties may be caught or pinned. The unit can be used near gasoline, gas, or any other flammable vapours that would preclude the use of an acetylene cutting torch. Remote control of the hydraulic ram, plus the extra long hose, enable the rescuers to work at a safe distance when necessary. The larger sets are valuable at train, bus and truck mine cave-ins building collapses, and other incidents where casualties may be pinned under concrete slabs, sections of collapsed buildings, street cars, or heavy machinery. There are many situations where such an extremely powerful, compact and versatile power tool can be used.

7. **Hurst Power Tool-** The Hurst power tool is a hydraulic spreading and pulling device that is completely portable, requires only one operator and is ideally suited for extricating persons trapped in any type of wreckage requiring the use of great force. This tool consists of a 5-horsepower engine which drives a hydraulic pump. Powerful jaws are connected to the pump by 16-feet-long (5-meter long) hoses, which attach to the tool with quick-disconnect fittings. The arms of the working device are activated by thumb controls located on each handgrip. When the arms are fully extended, they span a distance of 32 inches (80 centimetres). Two types of jaws can be fitted to the arms and held in place by retaining pins. One type is for spreading and lifting: it is commonly used at automobile accidents, elevator incidents, buildings collapse, and other rescue scenes in which heavy materials required moving. The other jaws are used for cutting-for example at aircraft accidents. The Hurst power tool operates with a maximum output of 10,000 pounds (4,500 kilograms) of force at the tips of the jaws; extreme caution, therefore, must be observed while operating this tool. The operator should wear full protective equipment, including gloves and face mask or safety goggles. The engine should not be started until all hose connections are made up and checked. Allow the engine to warm up. then open the choke. The controls should be operated through several cycles until the arms operate smoothly through their full range of movement from open to close. In extreme emergencies, the tool can be placed in operation immediately. To open or spread the arms of the tool, the thumb controls are moved in a direction away from the cylinder body. To close the arms, move the controls in toward the cylinder body. If the controls do not operate the arms in this manner, the hoses have been incorrectly connected either at the tool or the power unit. The engine is stopped by depressing the grounding switch. Before shutting down, the jaws should be left about ½ inch (15 centimetres) apart to allow for changing the jaws without starting up the engine.

8. **Pneumatic Chisel-** A pneumatic chisel is one of the safest, lightest, and most economical tools for extricating automobiles crash victims; in addition, it may be used for forcible entry into buildings, since it can cut openings in sheet metal doors. Body repair workers and muffler shops have been using air chisels for years; they can be safely operated in the presence of gasoline vapours (though this is not recommended) because they are free from sparks and flames. In addition to cutting sheet metal, air chisels can cut heavy door posts and can bear rivets, Pneumatic chisels are air hammers with chisel tips; they cut through metal with

a reciprocating motion like a jackhammer. To operate, punch a small hole in the metal. hold the chisel at a 30 angle, and hold the trigger down while applying moderate, steady pressure. These tools are convenient and easily portable since he compressed air may be drawn either from a breathing apparatus air bottle with a pressure regular or from a fitting on any vehicle equipped with air brakes. The air chisel requires about 4 cubic feet of air per minute at 100 to 150 psi pressure. As the material cut becomes tougher, the air pressure at the regulator should be increased to give the needed power to the hammer. For example. for cutting thinner metals such as in car roofs, the regulator need only be set to approximately 90 to 100 psi. When cutting through the frame or bumper, the setting should be in the 250 to 300 psi range. Because every material being cut will differ, due to such factors as rust, rigidity and supporting frames, it is impossible to give exact recommended air settings. All personnel on rescue squads must thoroughly familiarize themselves with this tool in practice sessions; this will allow the correct feel of the hammer to be gained and the crew will obtain some knowledge of the appropriate air pressures. It is important to remember that the air pressure should never be set higher than needed to do a particular job. Air consumption increases as air pressure is raised and the air supply is, therefore, exhausted sooner. There are a few safety rules that should be observed: Operators should wear full personal protection. including gloves and face mask or safety goggles: the air should be turned off or disconnected while changing chisels because an accidental triggering could launch a projectile: the cutting tool should always be held firmly against the work before starting and while making the cuts to eliminate the chance of it flying out of control and injuring someone.

9. **Hydraulic Jack-** A hydraulic jack contains hydraulic fluid which in turn is contained in a reservoir in the base and is forced by a pump actuated by the operating lever into the cylinder thus raising the ramp and the head-to lower the jack a relief valve is opened the speed of descent being governed by the degree of opening. The relief valve should, therefore, be operated with care to avoid a very heavy weight crashing down suddenly. Various types of hydraulic jacks are available, the common being the 5 ton and 12 ton jacks. The 5 ton jack is shown below:



10. **Hydraulic Gear Equipment.**

(a) **General**- The hydraulic jacking/gear equipment, when properly positioned and operated is capable of carrying out all such lifting and jacking operations normally required in rescue operations. It is remotely operated and controlled and can mean safer work both for the casualties and rescuer. In addition it is compact and can be inserted into confined spaces and small gaps enabling a powerful force to be exerted in positions hitherto inaccessible with the larger and heavier gears.

(b) **Equipment**- The hydraulic equipment issued consists of units comprising a pump (source of power) separated from a ram (power end) by sections of long flexible armoured hose. There are also attachments which can be speedily connected to the master unit enabling various tasks to be performed. The ram works in any position- upright, on its side, upside down or at any angle, and is in fact, all directional. Being separated from the pump by the flexible hose it can be inserted into small spaces and operated from a safe distance or in less confined positions. The apparatus is operated by oil pressure from the pump, through one or more lengths of hose, to the ram and its accessories or to the wedge spreader. By this means a lifting or spreading action can be obtained. The various items comprising the kit can be connected or disconnected by finger operated screw couplers. No tools are required. Under no circumstances should a coupler be slacked off or disconnected while the set is in use under load. The result would be pressure released, ram plunger collapsed, and oil lost. If for any reason the unloaded ram or wedge spreader is disconnected from the pump before it is fully collapsed, it must be re-connected to the pump before being finally collapsed, otherwise oil will be lost. The Hydraulic Rescue Kit comprises :-

(i) Pumps	-	2
(ii) 6 ft length of hose	-	4
(iii) Rams 6 ton capacity	-	2
(iv) Crewed adaptors for rams	-	2
(v) Wedge spreader	-	2
(vi) Alligator spreader	-	1
(vii) Rectangular flat base plates	-	2
(viii) Ram toes	-	2
(ix) Plunger toes	-	2

(c) **Detailed Description of an Equipment**.

(i) **Pump**- This is a simple hand operated pump which can be used at any angle between horizontal and vertically downwards, that is, with the hose connection pointing downwards. If the pump is allowed to point upwards, the oil will tend to flow away from the valve in the pump thereby preventing the pump from operating satisfactorily. The pump can be held in one hand and the handle operated by the other, or it can be placed on the ground and steadied during operation by placing one foot on the foot plate attached to the side of the pump body. On the side of the pump barrel is a release valve fitted with a small hand wheel. When this wheel is turned as far as possible in a clockwise direction the valve is closed and the pump is ready for use: by turning the hand wheel about half a turn in an anticlockwise direction. the valve is opened and the pressure is released. By careful operation of this valve the apparatus can be controlled within very fine limits when lowering. At the opposite end of the pump barrel to the hose connection is a cheese headed screw to which is attached a dip rod. By means of this dip rod the level of the oil in the pump barrel can be determined. For further details see para 25.32-36 "Maintenance"

(ii) **Hose** - Each 6 ft length of hose is fitted with a male coupler at one end and a female at the other. The hose are interchangeable with each other, are pre-charged with oil and ready for immediate use. The oil is retained in the hose by valves in the couplers A slight seepage of oil takes place as the couplers are engaged and disengaged but this is of no consequence. This loss can be minimised by pulling the couplers apart smartly after the screw has been undone. Great care should be taken to ensure that the inner washers are not displaced or lost.

(iii) **Ram and Screwed Adaptor-** This is a compact, portable ram, weighing only 5 lbs, but with a capacity to raise a load up to six tons. When closed its overall height is approximately 4¾ in. Its extension. i.e. the amount of lift, is approximately 2 in. Although this seems a small amount, it is so rapidly operated that, by using the normal procedure of packing as the lift proceeds, fresh bearings may quickly be obtained and a considerable total lift be speedily reached. The ram is fitted with a finger operated hose coupler. In the top of the ram is a detachable serrated saddle which can be replaced with a screwed adaptor for the with other accessories. The ram body is threaded externally for the attachment of the alligator spreader or ram toe. The ram can be used in any position.

(iv) **Wedge Spreaders**- This is an attachment which can be connected to the flexible hose, in lieu of the 6 ton ram, by means of a finger operated coupler. It consists of a pair of hinged wedges which under hydraulic power, can be forced apart thus exerting a spreading action at the tips of the wedges. Weighing only 4½ lbs the wedge is small and compact yet can be very useful for commencing to move, lift or spread loads, especially in confined spaces. The tip of the upper wedge is serrated in order to provide a grip and to minimise slipping When closed, the jaws are approximately ½ inch thick at the tips and under power open up to 25/10 inch. The recommended maximum load at the tip of the jaws is 15 cwt.

(v) **Alligator Spreader-** This accessory is an enlarged version of the wedge spreader, and requires more available space for its use, and has much greater range of separation than the wedge spreader. To assemble the alligator spreader for use, the serrated saddle is removed from the ram, and the alligator spreader is screwed to the ram body. The operation of the alligator spreader is effected direct from the plunger of the ram. Great care must be taken to see that the push rod of the alligator spreader is kept clean and free from damage, otherwise it will not engage with the plunger of the ram. The maximum load which should be applied to the alligator spreader is 1 ton.

(vi) **Jaws-** Somewhat heavier that the other parts (about 19 lbs), it consists of two opening jaws about 15 inch long actuated by the hydraulic ram. When closed it can be inserted into openings only 1¼ inch wide. Under power operation the jaws open or spread to about 11¾ inch, enabling loads to be moved sideways or lifted. The maximum load on the tips of the jaws should not exceed 20 cwt. The tips of both jaws are serrated to minimise slipping

(vii) **Base Plate and Ram Toe-** The base plate can be fitted by screwing it to the screwed adaptor which is then inserted in the ram plunger of the serrated saddle. The ram toe is screwed on the body of the ram. By standing the ram on the base plate and placing the ram toe under the load, the apparatus can be used in a similar manner to the toe lift on a normal jack.

(viii**) Plunger Toe**- This is used in conjunction with the ram toe by screwing the plunger toe to the screwed adaptor and fitting it into the ram plunger in place of the serrated saddle. The apparatus can then be used as a spreader.

(d) **Protection Measures**- Following protection measures may be taken during use of Hydraulic gear/jacking equipment: -

(i) **Screw Threads and Ram Plungers**- When couplers are disconnected, always screw on the dust caps which are attached to all couplers by chains. Keep the couplers clean and completely free from grit which would cause oil leakage and loss of pressure. Replace plastic caps when couplers are disconnected. Whenever possible guard the ram threads with the plastic protecting ring provided. The serrated saddle should always be kept in the ram unless the screwed adaptor is being used. Never use the ram alone unless the plunger is fitted with the serrated saddle, otherwise the plunger will be damaged and rendered useless. Make sure all threads are clean before engagement. Clean all items of the kit after use.

(ii) **Overloading**- Never attempt to lift a load that exceeds the capacity of the ram. Overloading causes cracked cylinders, blown cups and bent plungers. Cease pumping as soon as the action requires considerable force, an indication of overloading or maximum extension of the ram.

(iii) **Over Extension**- Because of the tremendous force of the hydraulic power, it is possible to push the plunger out of the ram. Be extremely careful not to extend the plunger beyond the limit of the engraved markings on the plunger.

(iv) **Off Centre Load**- Care must be taken whenever the load is not centred on the ram plunger. Loads will be off centre, for example, when using the ram and/or plunger toes. Pump carefully. When pumping is unusually hard stop operating and if possible, readjust the load. Off centre leads produce considerable strain on the plunger.

(v) **Care of Bow-Following precautions may be taken: -**

(a) A sharp impact may kink the wire made on which the strength of the hose depends Subsequent applications of pressure subject the kinked wires to stresses which eventually cause the hose break.

(ab) Never carry or if any part of the apparatus by means of the hose.

(ac) Avoid sharp bends Do not apply pressure from the pump when the line of hose has sharp bends. Always arrange the hose with easy flowing curves.

(vi) **Clearance**-Always position the set up so that the hose and couplers have clearance when the ram extends.

(vi) **Heat**- Keep the apparatus away from excessive heat which tends to melt the way siring of the cups and causes leakage. Heat also weakens the structure of the hose.

(e) **Maintenance**

(i) **Bank Caps**- Whenever any item of the kit is not in use the blank cap should be screwed on the coupler to protect the valves from dirt and grit.

(ii) **Pump**- From time to time the oil level in the pump should be checked. This can be done by holding the pump in a vice in a vertical position with the hose connected downwards and removing the cheese-headed screw in the top end of the barrel. To this www is attached a dip rod an oil should be added, if necessary, to bring the level up to the notch on the road. Do not overfill as the pump must have sufficient air space to function properly. After checking the oil level be sure the screw is well tightened, otherwise leakage may occur. When checking the oil level, occasionally drain the pump completely and flush out with paraffin: then refill to the notch on the dip rod as referred to above.

(iii) **Use of Oil**-Always use a good quality hydraulic jack oil when topping up or refilling the pump Brake fluid, alcohol, glycerine, and castor oil damage the cups and packings and should never be used. In cases of extreme emergency SAE 10 motor engine oil can be used, but should be replaced at the earliest opportunity with a good hydraulic jack oil

(iv) **Removal of Air from System**- It is possible that air might get into the system, hindering is proper operation. To remove air, close the release valve, and pump until the ram is fully extended, then open the release valve and place the plunger end of the ram on the floor, and slowly press down until it is fully collapsed, then close the valve and pump rapidly to 12 strokes. Keep the pump vertical with the hose end downwards. Repeat the procedure if necessary

(v) **Accessories**- Apart from keeping all screw threads clean, and oiling the moving parts of the wedge and alligator spreaders, no maintenance is called for.

(f) **Use of Hydraulic Gear in Rescue Operations**- Being easily transportable over debris, quickly assembled, compact when ready for use, and capable of exerting considerable power, the hydraulic jacking and spreading equipment has many and varying uses in rescue operations. It can be adapted to push, spread or lift loads under all sorts of different and difficult situations Being remotely controlled it enables the "power-end" of the apparatus to be inserted into a very small space whilst the operator can work in less cramped conditions. There is no limit other than that imposed by the length of the flexible hose to differing positions of the pump in relation to the ram which may be higher or lower than the operator as well as a way out in front of him. The comparative short lift or travel can readily be extended by frequent packing and re-siting whilst an initial gap between tool and load can be filled by timber extensions to enable the ram to exert its pressure. Some of the examples of its operations and uses are given below: -

(i) **Use of 6-Ton Ram for Lifting**: - The figure below shows the equipment assembled and being use to enable a straight -forward lift to be applied by the ram. As the force can be exerted sideways instead of vertically this arrangement can be used for spreading and pushing loads. Figure below illustrates a method of using the 6-ton ram to push a load. Utilising a sound wall as a base and using timbers to form an extension to the ram, the distance which the load can be moved can be increased at will. With the assistance of the baseplate and toe attachments, the 6-ton ram can be used to obtain an initial lift to a low-lying load, too heavy to be lifted by using the wedge or alligator jaws. The toe can he inserted under as little as 1½ inch working space and the load can be raised 2½ inch, packed up and another lift commenced. Recommended maximum load on the toe is 3 tons.

(ii) **Floor Lifting-** The principles of lifting outlined above, can be applied to raising a collapsed floor. It will first be necessary to expose the ends of the joists by clearing away brickwork and rubble to enable a spreader to be inserted to obtain a bearing under three or more joists. With the assistance of the alligator spreader the floor can then be raised to enable initial packing to be inserted. As soon as sufficient height has been obtained and adequate packing inserted, the alligator spreader can be replaced by the ram which can then be operated in stages to give the required lift. In the same way in due course both rams can be put into use, spaced apart under the collapsed floor so as to provide a space between them for the entry of the rescuer An additional length of timber can be placed over the head of the ram in order to obtain sufficient working height, but this should be kept as short as possible to avoid buckling.

(iii) **Use of Alligator Jaws-** It the tips of the jaws are positioned into a narrow opening and the power applied, heavy weights can be lifted or moved aside with very little effort. This method enables large portions of masonry to be moved and is particularly useful where there is little working space and where levers cannot be used efficiently. The jaws close to about 1¼ inch and open to approximately 11¾ inch.

(iv) **Use of Wedgie**- This diminutive but extremely useful piece of equipment is used in a similar way to the alligator jaws, but even less room is required in which to start the operations. As mentioned earlier, the jaws close to about $^{5}/_{8}$ inch and open to approximately 25/16 inch. As with the ram and larger jaws. this item can be used in many positions and situations, limited only by the length of the flexible hoses available.

(g) **Special Features of Hydraulic Lifting and Pushing Apparatus- These are:**

(i) The entire kit is very portable, and contains attachments which are quickly interchangeable and which adapt the apparatus for use in many different ways enabling a variety of operations to be carried out.

(ii) The pump permits very selective control and enables the load to be released very smoothly.

(iii) The flexible hose allows the use of the power tool in situations not normally or easily accessible and, with the additional extension hose fitted, enables the operator to work well away from the actual job. The interlocking quick-release couplings are standard to all connections and enable rapid assembly or change of attachments. The ram works in any position, upright, on its side or upside down, and is a powerful tool.

(iv) The spreading jaws enable heavy blocks of masonry or felled floors to be moved, requiring only a small space to enable the initial lift or movement to be obtained.

(v) Although the tips of the jaws are serrated in order to minimise slipping, the normal precautions should be observed when taking a metal-to-metal lift. Although maximum safe loads are given, in practice these would be difficult to estimate. If the operation of the pump handle becomes difficult, it is an indication that the load too great for the equipment. Under force should not be applied to the handle and under no circumstances should additional leverage be obtained by extending the handle by means of a length of piping.

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FLAME CUTTING

11. **General**- When iron or steel obstructions are encountered in the course of rescue work, the most rapid means of cutting a way through is with the oxyacetylene blowpipe. It should, however, be borne in mind that only readily oxidisable steels can be cut by this process, consequently stainless steel not being oxidisable cannot be cut with ordinary cutting equipment. Cast iron can only be cut by a special technique of weaving the blowpipe very slowly with a semi-circular motion. Brass, bronze and copper, which do not oxidise rapidly, cannot be cut. Bars and thin sections of these metals can. however, be melted away by the high temperature of the flame, and this may on occasion prove useful. Briefly, the equipment for this method of cutting consists of a cutting blowpipe, a cylinder of oxygen, a cylinder of acetylene and oxygen and fuel gas regulators devices which are screwed into the cylinder valves for reducing the pressures of the gases to those requirements at the blowpipe. To these regulators are connected lengths of hose for conveying the gases to the cutting blowpipe, to which their other ends are connected. The cutting blowpipe is the tool with which the severing of the steel is done.

12. **Principles of Flame Cutting**-The cutting blowpipe is so constructed that part of the oxygen entering it is mixed with acetylene within the blowpipe; the mixed gases issue from a ring of slots in the nozzle and when lit produce the very high temperature flame for heating the steel to be cut. The remainder of the oxygen separately controlled by a lever-operated value, issues as a jet of oxygen only. from a hole in the centre of the ring of heating flame jets. The action of flame cutting or more accurately, oxygen cutting relies on the fact that steel, when heated to incandescent (bright red heat) will oxidise or burn rapidly in an atmosphere of pure oxygen. The cutting blowpipe makes use of this phenomenon by employing the very hot oxyacetylene flame to heat a spot on the steel to incandescent and then making it possible to direct a jet of pure oxygen on to the heated spot and burn the steel away in a shower of sparks. The extreme tips of the pre-heat flames are the hottest part. So rapid is this burning action that it is possible to pierce a small hole through a piece of steel several inches thick in two or three seconds from the time that the oxygen jet first impinges on an incandescent spot on the surface

of the steel. In practice it is always advisable to start on the edge of the piece to be cut. It takes only a matter of a few seconds preliminary heating with the flame to bring a spot on the edge of the piece of steel to incandescent, the jet of "cutting" oxygen will then burn the steel, which produces additional heat. The heat of the flame plus the heat of the burning metal makes it possible to advance the blowpipe at speeds of from 6 inch to 2 ft per minute, always maintaining a hot spot in advance of the cutting oxygen jet so that the diameter of the hole in the nozzle from which the cutting oxygen issues. The purpose of having a ring of jets for the heating flame is twofold; it allows the cut to proceed in any desired direction, as by this arrangement there is always a part of the heating flame in front of the cutting jet while a considerable part of the remainder of the flame passes down the cut as it proceeds and maintains the necessary heat throughout the full depth of the cut. As flame cutting relies on rapid transfer of heat down the depth of the cut, it is more difficult to cut two or more riveted together then it is to cut a much greater thickness of solid metal, because the heat is not transferred so readily from plate to plate, particularly if there is any rust in the joint.

13. **Components-**The components required for cutting are assembled as shown They are as follows:

(a) An oxygen cylinder (painted black)

(b) An acetylene cylinder (painted maroon)

(c) An oxygen pressure regulator (painted black), right-hand screw threads. This is screwed into the valve mouth of the oxygen cylinder, after taking precautions given under the heading "Oxygen Cylinder".

(d) An acetylene pressure regulator (painted maroon), left-hand screw threads. This is screwed into the valve mouth of the acetylene cylinder, after taking the precautions.

(e) A 20 ft length of black rubber and canvas hose fitted with right hand screw thread coupling for conveying oxygen from the regulator to the blowpipe.

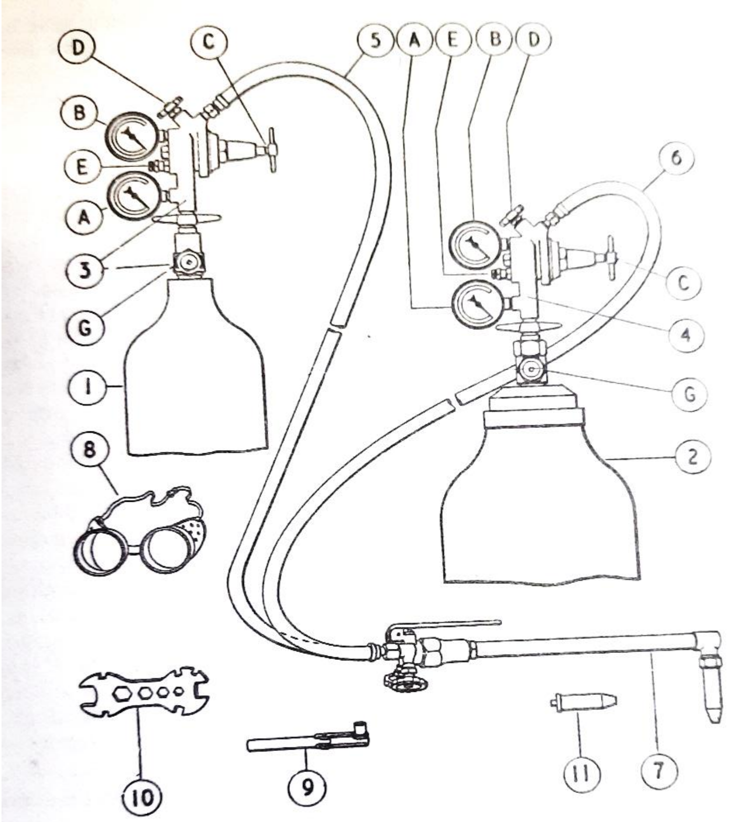
(f) A cutting blowpipe.

(g) A pair of goggles for protecting the operator’s eyes form sparks.

(h) a cylinder key for opening and closing the valves of the cylinders.

(i) A spanner for connecting and disconnecting hoses and nozzles and carrying out minor adjustments.

(j) Spare inner and outer nozzle for the cutting blowpipe.



Cutting equipment

14**. Other Main Features**

(a) When assembling, it must be remembered that maroon or red connects to maroon or red. and black connects to black. Cylinders, regulators, tubing and control wheels on the blowpipe are coloured maroon and black respectively to simplify correct coupling, but in addition oxygen connections are made with right-hand screw threads to prevent wrong coupling. NEVER change over coupling, or make or use adapters from right to left-hand threads or vice versa.

(b) The lower pressure gauge (A) on the regulator indicates the pressure of the contents of the cylinder, graduated in pounds per square inch.

(c) The upper pressure gauge (B) indicates the delivery pressure to the blowpipe, graduated in pounds per square inch.

(d) The delivery pressure to the blowpipe is controlled by the pressure adjusting screw (C). Screwing in increases the pressure, screwing out reduces the pressure.

(e). A stop valve (D) is provided at the outlet and should be fully opened (about two full turns) when operating.

(f) A safety valves (E) is provided to permit the gas to escape to open air in the event of any defect permitting excessive pressure to reach the delivery side of the regulating valve. Its purpose is to prevent bursting of hoses. The cylinders are provided with a stop valve (G) operated by the cylinder valve key.

(g) It is advisable to have at hand screwed couplers and additional lengths of hose for increasing the distance from the cylinder at which work can be done. Jointing pieces and worm drive hose clips should also be on hand for repairing hoses should they get torn or burnt under the arduous conditions which may prevail. It is inadvisable to use wire for securing hoses to couplers as it cuts and damages the hose.

15**. Care and Maintenance**

(a) **Oxygen Cylinder-**Oxygen cylinders are painted black. A full oxygen cylinder should show a pressure of 132 ATM or 1.980 lbs per sq inch. Cylinders must be kept away from heat and places where oil or grease might get into the cylinder valve, as heat expands the gas and increases the pressure in the cylinder, and oil or grease of any sort may oxidise instantaneously on coming in contact with high pressure oxygen, and so produce such intense hear that the valve or equipment may burn with explosive violence. Oxygen cylinders may be used in any position but care should be taken that they cannot roll or fall, as the regulator may be damaged. Before fitting a regulator to a cylinder, dirt and grit must always be blown out of the valve socket and screw threads by opening the valve quickly about a quarter of a turn and closing it again. Care should be taken to do this away from any smouldering material or lighted cigarette as the oxygen will cause such things to burst into flame. Soapsuds must never by used to test for leaks at a cylinder mouth as the fatty film left may have the effect of causing an explosion in the same way as oil mentioned above. Oxygen cylinder valve sockets have right-hand screw thread; thus, no attempt should be made to fit or adapt a left-hand threaded regulator to fit any oxygen cylinder. After a regulator has been fitted to any oxygen cylinder, the cylinder valve is opened very slowly by tapping the key, as a rush of oxygen may by its wave action, cause momentarily an intensely high pressure and temperature in the regulator which may ignite the seating and cause parts to burn with explosive violence. Oxygen must not be used to ventilate any tank or enclosed space for it may cause the operators clothing to burst into flame from a stray spark. A cylinder valve should always be closed before removing the regulator. Cylinders must be handled carefully whether they are full or empty, and not allowed to come in contact with electric cables, or placed where the blowpipe flame can impinge on them or where slag, or sparks from cutting. can come in contact with them.

(b) **Acetylene Cylinders**-Acetylene cylinders must be stored and used standing upright as the gas is compressed to a liquid which will otherwise be discharged to the detriment of cylinder and equipment. A full acetylene cylinder will show approximately 225 lbs per square inch pressure, but this may vary with temperature. The only accurate way to ascertain the contents is by weight. Acetylene weighs 1.1 oz per cubic foot. The tare or empty weight is shown on each cylinder, the difference between this and the weight shown by the scale if converted to ounces and divided by 1.1 will give the contents is cubic feet. Cylinders of dissolved acetylene become dangerous when heated up: -

(i) as the result of being involved in a fire:
(ii) by the decomposition of the acetylene and solvent contained in the cylinder.
(iii) as the result of backfire:
(iv) through careless handling of the cylinder when in use.

Once decomposition within the cylinder has begun, the action likely to prove most effective is to cool down the cylinder by the application of a copious supply of water applied in the form of a spray, leaving the cylinder in position. The release of gas by opening the main valve in an attempt to relive internal pressure will not ease the position. In fact, the passage of fresh gas through the hot spot will tend to accelerate the rate of decomposition and thus increase the risk of explosion. Where a cylinder of dissolved acetylene which has become hot is found with the main valve closed, the valve should be kept closed. Where a cylinder of dissolved acetylene which has become hot is found with the main valve open, the valve should) if practicable) be closed. The majority of dissolved acetylene cylinders are fitted with pressure relief devices of the following types: -

(i) a pressure relief disc in the body of the main valve.

(ii) a pressure relief disc in the body of the main valve and also a pressure relief disc in the base of the cylinder.

(iii) a fusible plug in the shoulder of the cylinder.

In the event of the pressure relief device operating and allowing the gas to escape, there is no way of controlling this escape of gas by means of the main valve. In these circumstances, therefore, the position of the valve is immaterial and if it is open, no attempt need be made to close it. When the cylinder is being cooled in position, after a reasonable lapse of time (not less than one hour) an exploratory examination should be made to ascertain that the cylinder is cooling, and further examinations should be made periodically until the officer in charge is satisfied that the cylinder has completely cooled. The cylinder should then be removed and immersed in a tank of water it should be left for 12 hours. In rescue operations e.g. where the cylinder is in building containing casualties, the officer in charge may decide to have the cylinder removed after decomposition has started. The cylinder should be removed to a place where any explosion or fire will be least likely to cause casualties or damage, and it should be in versed in water for at least 12 hours. Once decomposition has begun within the cylinder, it must be treated as an explosive missile and steps taken, in conjunction with the police to warn the population in the vicinity. Acetylene cylinder valve sockets have a left-hand screw thread; thus no attempt should be made to fit a right-handed regulator, or make or use, any adapter to convert from left to right hand thread. Before fitting a regulator, dirt and grit should be blown out of the cylinder mouth by quickly opening the valve about a quarter of a turn and closing it again, great care being taken that no flame hot metal, sparks, or smouldering material is in the vicinity. When fitting the regulator, extreme care is needed so that the bull nose of the regulator is clean and the wing nut tapped tight home to make a gas-tight joint. Acetylene has a very pungent odour, and it is possible to smell it round the valve joint as soon as the cylinder valve is turned on. Any leak should be stopped by further tightening before using, as a stray spark may ignite a leak and cause heating and possible explosion of the cylinder. Acetylene leaks should never be tested with a flame. Acetylene cylinders should be handled even more carefully than oxygen, cylinders and kept away from heat, sparks, fires and electric cables, the blowpipe flame and sparks and lag from cutting. Cylinder valves must always be closed before removing the regulator. Under no circumstances should an acetylene cylinder valve be left open, or leaking, as acetylene and air form an explosive mixture.

(c) **Regulators**-The regulator (Fig below) is a sensitive instrument working on a balance of gas pressure pressing on a flexible diaphragm in opposition to a pressure regulating spring (5). A pin projecting through the valve nozzle from the moving valve (10) is held in contact with the head of the diaphragm screw (9) by the resisting spring (23), consequently any movement of the diaphragm (8) causes movement of the regulating valve (10). It therefore follows that if the regulator screw (3) is screwed "in" it will through the spring (5) apply more pressure to the diaphragm (8) and cause it to move forward and open the valve (10) more, thus allowing a greater flow of gas and consequent increase of pressure blowing to the blowpipe through the outlet stop valve controlled by hand wheel (27). In like manner screwing the regulating screw (3) "out" will relieve pressure from the diaphragm (8) and reduce the delivery pressure.

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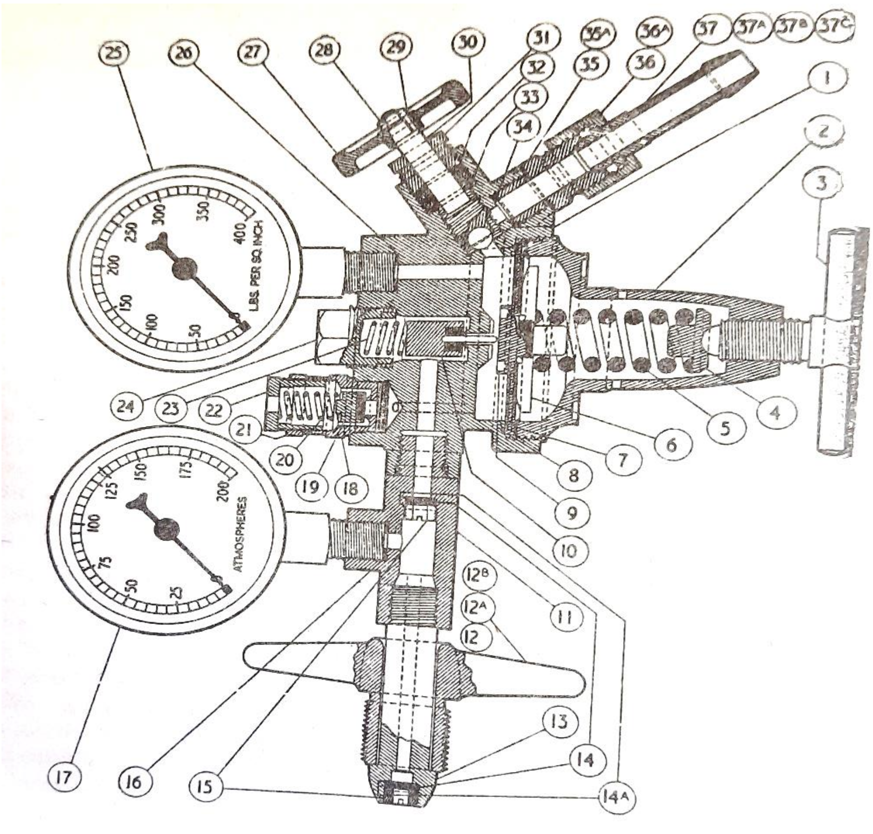
From this it will be seen that it is in effect an extremely sensitive balancing device and should consequently he treated with all possible care if it is to maintain its accuracy. Any dirt reaching the main regulating valve (10) is liable to cause this to become leaky, in which case the pressure will creep up on delivery side when the blowpipe is shut off and may burst the hose and will in any case waste gas through the safety valve (19). Also, the irregularity in pressure caused by a leaky regulating valve cutting difficult if not impossible, so it is important to take care that the regulator is not put down in dust or mud, when not in use, or when changing it over from one cylinder to another. Oil or grease must never be used on the screw threads, or any part of a regulator, as it may cause serious danger. The regulator is screwed into the cylinder mouth by hand, after seeing that the bull nose is clean, and tightened home with a few taps on the wing nut. Acetylene connections have left-hand threads, and oxygen connections have right-hand threads. After a regulator has been fitted to a cylinder and before opening the cylinder valve, the pressure adjusting screw (3), is screwed in until it is felt.



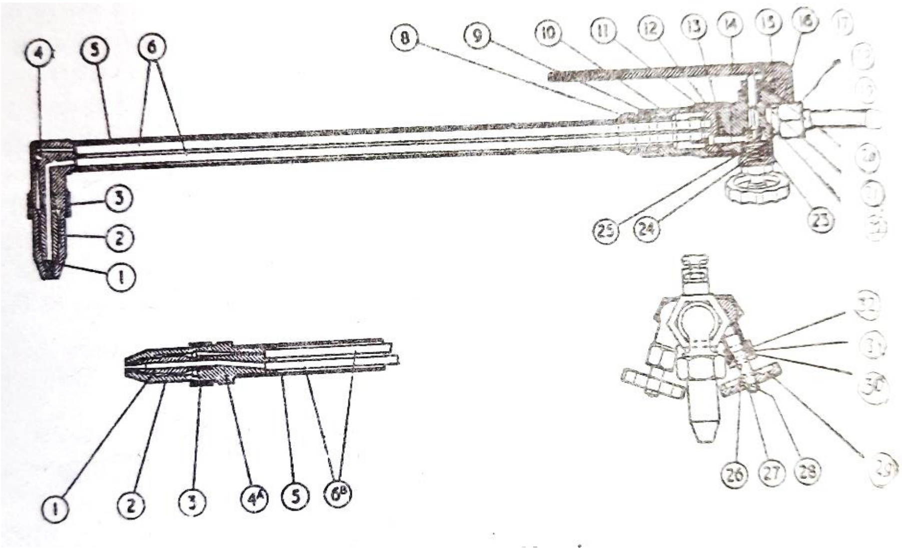
The regulators

(1) Body, (2) Spring Cover (3) Pressure Adjusting Screw (4) Main Spring Boss, (5) Pressure Adjusting Spring. (6) Diaphragm Plate. (7) Slip Ring. (8) Diaphragm, (9) Diaphragm Screw. (10) Main Valve (complete with Pin). (11) Inlet Tee. (12) Bottle Nut (Wing) (13) Bottle Sleeve, (14) Filter Gauge, (14a) Felt Filter, (15) Felt Nipple. (16) Gauge Joint Washer, (17) Contents Pressure Gauge. (18) Safety Valve Body, (19) Safety Valve Seat, (20) Safety Valve Spring (21) Safety Valve Lock Nut, (22) Safety Valve Adjusting Screw, (23) Main Resisting Spring. (24) Retaining Nut for Resisting Spring (25) Delivery Pressure Gauge, (26) Gauge Joint Washer, (27) Hand Wheel (28) Outlet Valve Spindle Nut. (29) Valve Spindle Key. (30) Outlet Valve Spindle, (31) Outlet Valve Gland Nut, (32) Outlet Valve Packing (33) Outlet Valve Gland Washer, (34) Joint Washer for Outlet Nipple, (35) Outlet Nipple in $^3/_8$ B S P. (36) Outlet Union Nut in B P. (37) Hose Connection.

that it is slightly compressing the spring (5). The outlet valve (27) is opened as is also the appropriate valve on the cutting blowpipe, if it is connected up. This will ensure that when the cylinder valve is opened the gas can pass through and a sudden rise in pressure is thus avoided. The cylinder valve is opened slowly by tapping the cylinder key with the hand and, as soon as the cylinder contents gauge ceases to rise, opened about three full turns. The regulator outlet valve, or the valve on the cutter, is closed, and all connections tested to see that they are gas right. When turning on the cylinder valves the cutter is kept away from any naked flame, but metal, or smouldering material. The pressure can only be adjusted when gas is flowing through the cutter, to do this the regulating screw (3) is screwed "in" to increase pressure and "out" to reduce pressure.

(d) The ends of hoses should not be dropped into mud or dust as any dirt in the hose will be driven into the cutting blowpipe and may cause choking of the small gas passages. The nose connections in the end of the hoses must be clean before connecting to the regulator, and the spanner must be used to nip the nuts up right to prevent leakage. Red hose with left-hand screw thread connections should be used for acetylene, and black hose with right-hand threaded connection for oxygen. It is advisable to blow gas through the hose before connecting up to the cutting blowpipe if this can be done at a safe distance from any flame, hot metal or smouldering material. Great care should be exercised to see that hoses are coupled up "gas tight" particularly when working in confined spaces. An oxygen leak is as dangerous as a fuel gas leak, because it may cause clothing to burst into flame if a spark settles. The hoses should be kept clear of hot metal that has just been cut and not dragged over sharp and jagged material.

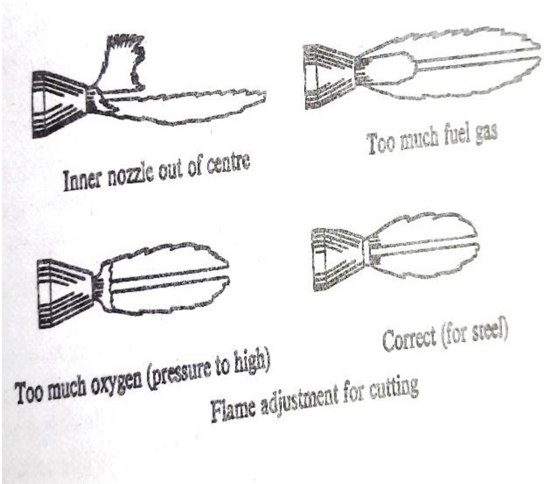
(e) **Blowpipe**-With one type of cutting blowpipe the faces of the valve control wheels are painted maroon for acetylene and black for oxygen to assist correct coupling, but the screw threads are also left-hand for acetylene and right-hand for oxygen to prevent mistakes.



One type of cutting blowpipe

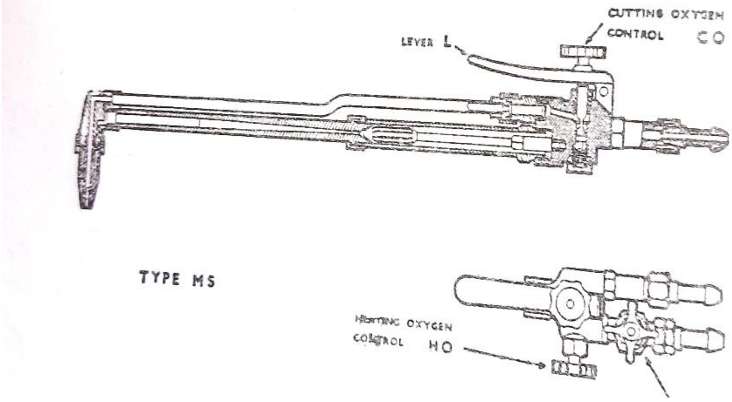
(1) Inner Nozzle, (2) Outer Nozzle, (3) Head Union Nut, (4) Elbow Head. (4a) Straight Head. (5) Main Tube. (6) Heating and Cutting Oxygen Tube (two) (8) Main Tube Sealing Nut, (9) Main Tube Sealing Ferrule. (10) Distributor Union Nut. (11) Distributor Block (12) Distributor Joint. (13) Distributor Dowel Tube. (14) Cutting Oxygen Lever, (15) Cutting Oxygen Lever Taper Pin (16) Valve Body. (17) 3/88SPRHUnion Nut, Oxygen, (18) 3/8 BSPLH Union Nut Acetylene. (19) 5/16 in-3/8 in Hose Connection (two), (20) Cutting Oxygen Gland Nut (21) Cutting Oxygen Gland Packing Rings (22) Cutting Oxygen Valve Plunger, (23) Cutting Oxygen Valve with eating material, (24) Cutting Oxygen Spring Cap. (25) Cutting Oxygen Spring (26) Oxygen and Fuel Gas Spindles (two), (27) Oxygen and Fuel Gas Nuts (two), C28) Oxygen and Fuel Gas Key Pins (two), (29) Oxygen and Fuel Valve Wheels (two), (30) Oxygen and Fuel Gas Gland Nuts (two), (31) Oxygen and Fuel Gas Packing Rings (two), (32) Oxygen and Fuel Gas Gland Rings (two).

Dirt or grit should not be allowed to enter the inlet sockets of the cutter when it is dis connected from the hose. When connecting the hoses, the union nuts are tightened with the spanner, the blowpipe being held in the hand. A vice is not necessary. The "splined" nozzles supplied with this cutter are self-centring so that an even flame will be produced so long as the slots down the tip of the inner nozzle are kept clean. Other nozzles can be used but care



Flame adjustment for cutting

in centring will be necessary to ensure an even name. Slacking of the head union nut and wing the out will often rectify slight eccentricity with such nozzles. The two screw stop valve (N) below the body of the cutting blowpipe, control the oxygen and acetylene respectively for the heating fame, while the lever (14) above the body controls the "cutting" oxygen. The heating flame is set to neutral by adjusting the two stop valve. Depressing the lever permits the follow of the stream of pure oxygen which cuts or burns the already heated metal. If an intermittent popping occurs, or the flame is blown out when the cutting lever is depressed it will probably be due to the inner nozzle (1) not being seated "gas tight" in the elbow head. The outer nozzle should be removed by unscrewing the head union nut (3), and i.e. inner sole (1) and, after seeing that the face is clean, screw in again fairly tightly with the spanner Undue strain, however, must not be exerted or the nozzle may be broken off at the end of the screw thread. Should this occur no attempt should be made to remove the part with a file tang as it will almost certainly damage the seating and screw thread. Another possible cause of popping, or backfiring is a leak at the distributor joint (12). This necessitates thorough overhaul of the cutter. It will, from time to time, be necessary to tighten the gland nuts (20 and 30) of the valves to compensate for wear of the gland packing, Care must be taken that they are only tightened sufficiently to prevent leakage and that the free movement of the valves is not impeded. A blowpipe must never be used as a flare for illumination purposes as the incandescent flame reflects it heat back on to the inner nozzle



Another type of cutting blowpipe

and may melt it away at the tip If a nozzle should become burnt at the tip it must be renewed, as it will cause constant backfiring which will soon damage the blowpipe internally. The other type of cutting blowpipe used by the Rescue Section has a nozzle and tree valves, viz, the acetylene, or fuel gas, valve (A): the heating oxygen valve (H O) and the cutting oxygen valve (CO) The nozzle is of the two-piece type having a central orifice for the catting oxygen and an angular orifice for the preheat flames. When valves (A) and (HO) are opened a mixture of oxygen and acetylene passes through the preheat gases tube to the outer orifice and provide the flame for heating the metal to the "ignition" temperature. When the cutting oxygen control valve (CO) is opened by releasing the lever L. oxygen passes through the cutting oxygen tube to the central orifice of the nozzle, and providing the metal is preheated to the correct temperature, brings about the oxidation of the metal to effect the cutting action. The force, or velocity, of the oxygen is such that it blows away the oxidised metal and prevents it from fusing together again, this forming a "Kerf" or cut.

(f) **Goggles**-Goggles should always be worn when cutting as sparks of molten metal and oxide are liable to fly up on to the operator and may cause serious damage to the eyes. Such sparks pit the surface of the goggle glass and for this reason a plain cover glass is fitted in the goggles in front of the protecting coloured lens. This cover glass should be renewed from time to time.

16. In preparing for cutting operations, the gases at the cylinder valves, regulator outlet valves and at the blowpipe are turned on. After it is ascertained that both gases are flowing, the oxygen valve at the blowpipe is closed, the blowpipe is lit and the oxygen valve turned on. The pressure of oxygen and acetylene should be set for the thickness of the steel to be cut in accordance with the following table. (This is done by means of the pressure adjusting screws (3) of the regulators. The oxygen pressure should be set when the cutting lever is depressed). The flame is set to neutral, the final adjustment to the flame being made when the cutting lever is depressed. It is always easier to start a cut on an edge than in the middle of a piece of steel, so whenever possible the cut should be made in from the edge. To start a cut the blowpipe tip is held about 1/4 inch above the edge of the plate with the cutting lever up; in a few seconds a spot on the edge, will be incandescent. The blowpipe is moved so that only half the flame is over the plate and the remainder blowing down the face. The lever is the cutting oxygen turned on and the blowpipe moved slowly and steadily in the direction in which it is desired to cut. This will cause a narrow slit to be burnt right through the steel. Jumpy movement must be avoided and care must be taken to keep the nozzle approximately the distance from the face of the work given in the table. The speed of advancement depends on the thick ness of the steel being cut. The operator soon gets to know if the speed of travel is too great and when the cut is not penetrating as slag and sparks are thrown out of the cut.

Material Thickness	Nozzles Inner		Outer	Oxygen Pressure lbs per sq. in	Acetylene Pressure lbs per sq. in.	Distance of Nozzle from work	Cutting Speed ins per min.
1/8” to 5/6”	1/32”		Small bore	20 to 27	1 to 2	3/16”	22” to 14”
3/8” to 5/8”	1/32 ” 3/64 ”	or	-do-	27 to 35	1 to 2	3/16” to 1/4”	14” to 11”
¾ ” to 5/8”	3/64”		-do-	35 to 45	1 to 2	3/16 ” to 1/4”	12” to 9”
11/8” to 2”	1/16”		-do-	45 to 55	1 to 2	¼ ” to 5/16”	9” to 8”
2 ¼ ” to 3”	1/16” 5/64”	or	Large	55 to 65	2 to 3	¼ ” to 5/16”	8” to 7”
3 ¼ ” to 4”	5/64” 3/32”	or	-do-	65 to 75	2 to 3	¼ ” to 5/16”	7” to 6”
4 ¼ ” to 6”	3/32”		-do-	75 to 80	2 to 3	5/16” to 3/8”	6” to 5”
6 ¼ ” to 9”	3/32” 7/64”	or	-do-	80 to 90	2 to 3	3/8” to 7/16”	4 ¼ ” to 3 ½ ”

If a start cannot be made on an edge, a considerably longer heating period will be required to get the hot spot to a sufficiently high temperature to start burning. The lever should not be depressed and the cutting turned on until the metal is hot enough to burn, as it will only blow it cold. When a really incandescent spot has been made the nozzle is raised to about 3/4 inch from the metal and the blowpipe turned side-ways to an angle of about 45 degree and the lever depressed slowly. In this way the sparks and oxides will be blown away whilst piercing takes place instead of being blown up on to the operator. As soon as the metal is pierced, which will be known from the sparks no longer flying back from the hole, the cutter is straightened slowly and the cut proceeded with as usual. The lever is always released on finishing a cut, or moving position to continue a cut, as otherwise a ragged gash will be made and sparks will fly in all directions as the cutter is lifted from the work. The tip of the nozzle must never be allowed to rest on the work, or be dipped into the molten metal, as this will cause a backfire-i.e. the flame to burn within the blowpipe. If this occurs the two-heating flame stop valves must be shut off with the utmost speed to extinguish the flame, otherwise the nozzle and elbow head may be melted. The nozzle is re-lit by turning on the acetylene and lighting at a flame, or by turning on both gases and lighting by means of a smouldering piece of old tow or rope. If on completion of a cut it is found that in one or two places the metal is not completely severed, the nozzle should not thrust into the cut already made, but work started again o the edge of the cut and a fresh cut made round the defence cut. The reason for this is that while steel will burn, steel oxide will not, so that it is no use trying to burn down in the cut, which is probably filled with slag and oxide. It is always difficult to start a cut on a round bar because there is no edge to heat. It is better to travel a little too slowly than too fast when cutting, for if the progress is too rapid the blowpipe will overrun the speed of penetration and please will be left not completely served or the cut will be “lost”- i.e., the steel in front of the cutting jet will not be incandescent and so will be blown cold by the oxygen stream instead of being burnt. Should this happen a recut on the edge of the old cut should be made so as to be sure that steel is being cut and no attempt being made to cut oxide and slag. When work is finished the cylinder valves should be shut off and the pressure released from the hoses by opening the heating gas valves on the cutter.

17. **Backfire**-When cutting in the corners of angle irons and other such places, the flame is thrown back on the nozzle of the blowpipe, which becomes overheated and may backfire. If possible, bucket of water should be at hand so that the cutter can be called by immersing it in water, with the heating oxygen valve just "cracked" so that a little gas is issuing to prevent the water entering the cutter. If there is a defect in the cutter such as a split inner tube (6) or a leak at the distributor joint (12), a backfire may go back into the oxygen or acetylene hose and burst

or burn it. In this case the blowpipe should be shut off at the cylinder and not used again until it has been thoroughly overhauled and tested. Charred or burnt hoses should not be used the charred rubber and the gases released by the heat will almost certainly cause further bad backfire, even if a blowpipe which is in good condition is used.

18. **Notes and Precautions**:

(a) Do not use higher gas pressure that those given; it will slow down rather than increase the speed in cutting Set the pressures when gas is flowing. (b) Always be careful that the equipment is coupled up properly and that there are no leaks.

(c) Always remember that left hand thread nuts have a groove in the middle, and right-hand nuts are plain. Left hand thread is used for acetylene and other fuel gases; right hand threads are used for oxygen.

(d) Use no oil, grease or fatty substance and keep all equipment away from contamination by such substances. A mere smear of oil on oxygen equipment can, in contact with high pressure oxygen, cause serious accidents.

(e) If the blowpipe is lit at a flame or by a spark lighter it is best to turn on only the acetylene and afterwards turn on the oxygen. If it is lit at a piece of smouldering rope or tow, the oxygen also must be turned on slightly.

(f) If the flames snap out when lighting, or when cutting immediately close the heating oxygen and fuel gas valves for a moment to extinguish the flame inside the cutter, then open and relight.

(g) Keep the nozzles clean and free from incrustations of slag. Scrape these off carefully.

(h) Do not use the blowpipe as a hammer, or lever, to break away slag which is holding a cut plate.

(i) Take care to work in such a way that on completion of a cut, the cut piece cannot fall and cause injury, nor can it release debris which may cause danger.

(j) If cutting has to be performed near a trapped person, protect him with asbestos or other suitable material against being burnt by sparks and slag.

(k) When cutting bars in reinforced concrete, the heat will cause the concrete to flake and fly with great force, so take precautions to avoid cuts and burns.

(l) If a blowpipe will not burn properly it may be due to à cylinder valve being only slightly opened, a regulator outlet valve being only partly open, or a cylinder being empty, try the valves and observe the pressures shown by the contents gauges before putting on new cylinders.

19. **Cutting Metals other than Mild Steel**-Stainless steel, when incandescent, will splutter buy will not cut Thin sections can be melted away by the flame only. Thin brass, copper, and aluminium can be melted away by the flame only but cannot be cut. The flame is set as large as possible and the blowpipe held at an angle of about 20 degrees to the surface and moved slowly forward as the metal melts in front of it. Cast iron can be cut by a special

technique. The flame is set as large as possible with a feather of excess acetylene about 1 inch long. Heating is done not merely at the top edge but down the face to be cut until the piece is well heated. When heated to incandescence at the top edge, the cutting lever is depressed and work carried out in a semi-circle with about ¾ inch diameter and weaving across the line of the cut, each complete cycle taking about ten seconds. On each pass a bite hack about ½ inch to ¼ inch is made in the direction of the desired cut. This slow movement allows time to break down the graphite and maintain a hot spot. There is a tendency for a shelf a slag and graphite to form about ¾ inch down in the cut, and it is only by swinging with the very slow semi-circular motion on the sides of the cut that this can be made to break away so that the cut can penetrate. Practices is necessary to maintain the cut and in any case the speed of progress is extremely slow as compared with steel cutting, while the width of the cut made is from ¾ inch to 1 ¼ inch wide and is very irregular.

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CHAPTER 8

PORTABLE FLOOD LIGHTING

1. **General**-Where rescue operations have to be undertaken after dark, the use of flood lighting will make work easier and quicker by giving additional light where it is most needed, e.g. in reconnaissance, in certain methods of rescue, in showing up dangerous structures or in unloading and carrying of equipment, or traversing debris. The type of flood lighting employed must therefore be portable, capable of being quickly brought into action, and robust enough to stand handling over debris. The projectors will be carried on the rescue equipment vehicle of each rescue group. The permitted use of flood lighting during enemy activity will be at the discretion of the Controller. The direction and siting of the flood lighting units will normally be under the control of the Incident Control Officer, although the equipment may, if necessary, be employed to assist single parties. In siting lamps, care must be taken to avoid shadows thrown by obstacles, e.g. walls, posts, debris, between the lamp and the area to be illuminated. This may necessitate placing lamps at a height well above the ground or surface, e.g. on remaining structures, or perhaps on tripods or other supports.

GENERATOR SETS

2. **Equipment**- A number of portable generator sets are available in the market which can be used effectively during rescue work either at the point of rescue or lighting the whole building. Main features of portable generator set, Honda EBK 2000 are mentioned below:

(a) Technical Specifications

Particulars	Unit	EBK 2000
(i) Engine Type		Air cooled 4 stroke single cylinder
(ii) Fuel		Kerosene (petrol start)
(iii) Rated AC Output	Watts	1400
(iv) Max AC Output	Watts	1600
(v) DC Output	V/A	12V-8.3A
(v) Rated Current (AC)	Amp	6.4
(vii) Fuel Tank Capacity	Ltr	9.1
(viii) Continuous Operating Time	Hrs	7.2
(ix) Fuel Consumption.	Ltr/Hr	1.26
(x) Lubricating Oil Capacity	Ltr	0.7
(xi) Dimensions (LxWxH)	mm	545x360x475
(xii) Dry Weight	Kgs	49
(xiii) Noise Level (db-A/7m)	db	68
(xiv) Other Features:		Yes
Circuit Breaker		CDI
Ignition System		Yes
Oil Alert System		Yes
Brushless Generator		Yes
Noise Suppressor		Yes
AC Voltmeter		

(b) **Main features-** The following are the main features of Portable Generating Sets.

(i) **Four stroke Technology**

(aa) Eliminates premixing of engine oil with petrol.
(ab) Ensures cleaner exhaust, minimising pollution.
(ac) Uninterrupted, smooth running
(ad) Maximises fuel economy.
(ae) Greater power and durability.

(ii) **Exceptionally Low Noise- Quietest in their Class**-Specially designed muffler, air cleaner and rubber mountings reduce noise level.

(iii) **Electronic Ignition:-**

(a) Ignites with just one pull start.
(ab) Eliminates tumble some contact points
(ac) Minimal maintenance required.
(ad) Lowest operating cost.

(iv) **Oil Alert System**-Automatically stops engine when oil reaches a specified low level. thereby preventing engine seizure.

(v) **Brushless Capacitor Excitation (BCE**)

(aa) BCE voltage regulation gives smooth, stable output.
(ab) No separate automatic voltage regulator required.
(ac) Maintenance easier and more economical as there are no brushes to be replaced

(vi) **Muffler Guard**-Prevents accidental barns as it is enclosed in an exhaust projector.

(vi) **Features enhancing convenience and durability**

(aa) Circuit breaker-one touch resendable AC/DC circuit breakers help prevents overload damage.

(ab) Simultaneous AC/DC output provides greater versatility-can power electric appliances and charge batteries 100.

(ac) Large fuel tank for long continuous operation

(ad) Light weight tough aluminium frame of EM 650 enhances portability

(ae) Full pipe frame of EBK 2000 ensures generator protection and enables easier handling.

(af) Conveniently located controls.

RECHARGEABLE EMERGENCY LIGHTS

3. Each rescue party may be allotted a rechargeable emergency light. These are available in many designs and are useful for spot light/room lighting. It can effectively light a room of 20x207. Is will also prove effective during tunnelling etc.

IMPROVISED METHOD OF LIGHTING

4. In case the generators are not available the head lights of available vehicles can be lit to light up the area.

5. Conclusion-Care should be taken not to use any equipment which is likely to cause fire due to various gas leaks.

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CHAPTER 9

ROPES AND LASHINGS

1. **Introduction**-Ropes form an important item in rescue equipment as number of problems can be solved by proper use of ropes. Experience has proved that incidents occur where persons have to be rescued from above or below the ground level, thereby involving lowering or boosting Under such circumstances an insecure or a wrong rope or a bad splice or wrong knot incapable of carrying the strain may result in considerable delay in operations and also involve rescue. The proper selection and right use of ropes therefore gains importance in rescue work.

2. In rescue work knotting's and lashings are required for joining and securing ropes and for fastening ropes around objects and persons, and to lower, hoist or secure with safety. Knots must be tied tightly.

3. As knotting and lashing are to be done on the spot, where the party is fighting against time, in darkness, in smoke, when people are killed dying and when civilian population is panic stricken, it is very necessary for everyone in the Rescue Party to learn knotting and lashing, so thoroughly that it becomes a habit and they should be able to do this under all such abnormal conditions.

4. Rescue parties may be equipped with the undermentioned types and sizes of ropes.

(a) Two 200 feet (60.96 M.), length of 3" (76.20 mm) rope- these are principally used along with tackles and pulleys for raising or lowering persons or articles etc.

(b) Ten 40 feet (12.19 M.) length 1 ½ (38.10 mm.) lashings these are used for securing casualties to stretchers, as guy ropes to the construction of derricks and sheers, as guide ropes etc.

(c) Eight 15 feet (4.57 M.) length of 1" (25.40 mm.) sash cord used as short lashings for all general and light works.

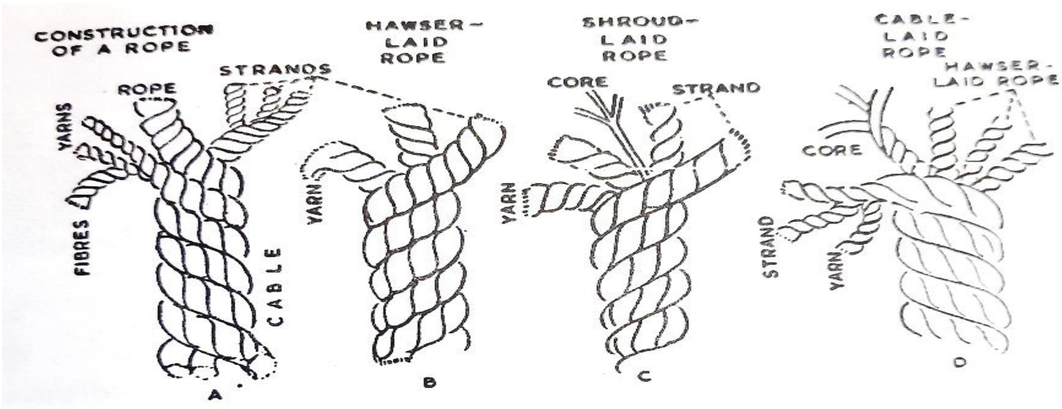
(d) One coil of steel wire rope 100 feet (30.48 M.) long $^{5}/_{8}$" (17.30 mm.)- used for heavy work
such as demolition of dangerous buildings etc.

ROPES

5. **General**-The term 'rope' is used for both fibre and wire ropes, while the term 'cordage' is used to denote fibre ropes only. Cordage and ropes which are in general use are made principally of Hemp and Manila, and to a lesser extent of sisal, coir and cotton and other vegetable fibres. Rope is also made of steel wire. Hemp when wet is less likely to swell, and for reasons of softness of its fibres and flexibility has longer life and can be used over short radial curves. Manila is practically water proof and as much is also used for making net for fishing industry. The strands of these ropes will maintain their lay when opened out. This makes them easy to handle in splicing and are, therefore, particularly suited for rescue work. Sisal, though of the same strength as Manila, swells when wet and becomes slippery. Coir, owing to

its buoyancy, will float on water. It is noted for elasticity but lacks in strength. Cotton is more susceptible to damage from chaffing. It is also most difficult to splice and its strands will not retain their lay when undone.

6**. Construction and Laying of Ropes-** The first process in the manufacturing of ropes consists of combing of fibres on a series of special machines, so that they are arranged roughly parallel, in which stage it is known as 'Sliver'. The next process is spinning when a permanent twist is mechanically imparted to the sliver which is then known as 'yarn'. It is the smallest divisible part of a laid rope. A series of yarns twisted together form strands, and three or more strands twisted together form a rope. Rope is normally made in lengths not exceeding 120 fathoms or 720 feet (21946 M.). The manner in which yarns, strands or ropes are twisted together to form larger units of cordage is known as "laying Rope may be laid up' right hand or left hand lay respectively. The lay can be determined by booking at the rope. Most rope is three stranded and usually laid up right-handed in the strands run from the bottom left hand to the top right hand in a clockwise direction. This is called hawser-laid rope. A hawser-laid rope is the strongest rope. The central core is made up of short strands and acts as a " former" only. There hawser-laid ropes laid up together left handed, with or without a central com, is called a 'cable laid rope' Cable laid and shroud-laid ropes are weaker than hawser-laid ropes (refer sech below):



Construction of Rope

7. **Strength of rope-**It must be remembered that any knot tied in a rope weakens that mope and a bad or unsuitable knot weakens a rope considerably more than a well tied one. Knots tums and hitches weaken a rope by forming a bend which distributes the strain on the fibres unequally. An eye splice weakens a rope by 10%, a short splice by 20%, a timber hitch by 35% and a reef knot by 50% Ropes are always described by the measurement of their circumference that is an inch rope or 3 inch rope etc. Strength of rope and its ability to withstand strain and stress depends upon the material of which it is made, how it is made, how is it used and care and preservation during and after its use. As a rough guide to the breaking strain of a hemp rope the following will be found to be a fairly accurate formula:-

(a) Breaking strain $= \dfrac{\text{Circumference}^2 \text{ tons}}{3}$

(b) Safe working strain $= \dfrac{\text{Circumference}^2 \text{ tons}}{18}$

8. A safe working strain is always less than the breaking strain.

TYPES OF ROPES

9. Ropes may be of either fibre or metal or sometimes mixed construction. The general description applied to all forms of fibre rope, line and twine is cordage. Ropes made of metal are referred as Steel Wire Rope (SWR). Broadly all ropes can be grouped under three categories:

(a) **Natural fibre ropes-These are principally made of:-**

(i) **Hemp**-It is a rough rope but a very strong one and is used in pioneering and in-board of ship to a great extent.

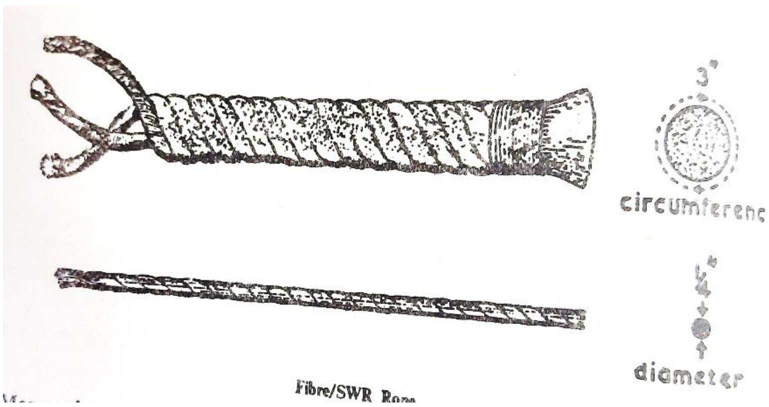
(ii) **Italian hemp**-It is a fast fibre obtained from stalks of the hemp plant. The fibre is soft and stronger than the other hemps. It does not harden when wet and is the strongest of all vegetable ropes

(ii) **Manila**-It is made out of a fibre obtained from the leaf sheets of the abaca plant. It is more expensive, strong, smooth and is used in yachting.

(iv) **Sisal**-Fibre obtained from leaves of sisal plant; it is as strong as hemp and is sea water resistant.

(v) **Coir**-A fibre obtained from husk of coconut. It is a very light rope, elastic and floats on water. Its strength as compared to hemp is ¼ (Refer sketch).

(vi) **Cotton**-It is the fibre obtained from the seed pods of the cotton plant. It is rather weak but smooth.



Fibre/SWR Ropes

(b) Man made fibre ropes-The two Principle fibres used are:-

(i) **Nylon-** A fibre with a complex forms structure of carbon, nitrogen, oxygen and hydrogen.

(ii) **Polyester** - It is derived by chemical synthesis from the products of mineral oil crackers. It is also known as treeline.

(iii) **Properties**-These ropes are flexible and run well over blocks or pulleys and can be knotted, sized or sliced. Tensile strength is an important property of such ropes. They are approximately twice as strong as compared to ropes made out of vegetable fibre other major properties are:-

(aa) Can absorb shock loads.

(ab) Withstand repeated loading of a high order.

(ac) Little swelling on being wet.

(ad) They can be stored when wet without any degradation.

(ae) They are resistant to most of the dilute forms of acids and alkalies.

(c) **Steel Wire Rope (SWR)-** Wire rope is a combination of steel wires arranged around a central fibre core. Steel reaches the wire mills in the form of rods, which are first cleaned in acid to remove rust. After heat treatment to ensure uniformity in tensile strength, ductility etc. they are cleaned again before being drawn cold through a series of dies each of which gets successively smaller until the required size is reached. After drawing, the wire may be galvanised according to requirements. The breaking load of wire rope is considerably greater than that of fibre rope of equivalent size, but it is far less flexible and more difficult to handle. Its use by fire brigades is, therefore, generally limited to equipment which is operated by means of a winch, such as wheeled escapes, turnable ladders and some extension ladders. Steel wire ropes are about nine times as strong as corded ropes of the same thickness. The wire bonds ("scaffold lashings") used by the Rescue Section are ¼ inch diameter ($^{3}/_{4}$-inch circumference) hemp core galvanised wire ropes. If in good condition they will take a load of approximately ¾ x ¾ x9= 5 cwt. (Refer sketch) - The recommended minimum diameter about which a steel wire rope can be bent without causing harm to the rope is six times the circumference of the steel wire rope; e.g., 5/8-inch diameter steel wire rope equals 2-inch circumference which six times equals 12 inches minimum diameter. It is not advisable to use steel wire ropes with fibre rope pulley blocks.

CARE AND MAINTENANCE OF ROPES

10. Rope is expensive but with proper care will last for a long time. Some of the aspects requiring attention with regard to their care and maintenance is as follows: -

(a) Fibre Ropes

(i) Keep all fibre ropes as dry as possible. When damp, they should be dried in shade before coiling and stacking to avoid danger by mildew. No rope should ever be stored wet.

(ii) A stiff and hard rope gives trouble. Stretch a new rope throughout its length before using it. Remove the twists and pull at both ends.

(iii) Remove kinks out of a new rope before using it, by uncoiling it and recoiling it in the opposite direction, for two to three times as kinking tends to draw the fibre apart and weakens them.

(iv) Always coil a rope in the direction of its lay, e.g., a hawser-laid rope is coiled in the clock. wise direction. After coiling, tie with hemp at least in three places.

(v) Keep all rope coils hung on poles or bamboos. Keep each type labelled, so that the correct size of ropes can be taken out of the stores when necessary. All lashings should be kept in bags or bundles.

(vi) Avoid permanent knots in a rope as this reduces the strength of a rope. Do not attempt to force a thick rope through a block made for smaller size. This produces strain and reduces the strength of the rope. Also avoid sudden jerks.

(vii) Ensure that ropes do not come in contact with any chemicals or materials containing chemicals or strong alkali such as Creosote. Also protect the ropes from rats.

(viii) Avoid dragging the rope along the ground, as it drives grit into the fibres and subsequent internal movement between the strands will cause the grit to cut into the fibres and seriously weaken them. Also avoid chaffing against sharp edges.

(ix) Oil and grease must not be put on ropes as the fibre material produces their own lubrication. Moreover, application of lubricants prevents oil from getting to the fibre.

(b) **Steel Wire Rope**

(i) Steel wire rope should be cleaned with a rag after use and well-oiled before keeping it in the store.

(ii) When a steel wire rope has to be coiled, ensure that the coil must not be below the recommended diameter i.e., six times the circumference of the steel wire rope, otherwise strands may get damaged.

11. **Inspection of Ropes**- Ropes should be regularly inspected to ensure that their condition is good, since the risk involved in rescue work is already great and bad ropes will make the matters worse. Therefore, look for the following defects while inspecting the ropes:

(a) **Surface Defects.**

(i) Broken fibres	-	These can be seen by visual inspection.
(ii) Wear	-	Thinner than the usual circumference-uneven surface.
(iii) Cuts	-	These can be seen and felt while coiling

(b) Internal Defects.

(i) Broken fibres. - At places where there is a bulge in the rope untwist and see for this.

(ii) Mildew of Mould - - When the ropes are used in wet weather or when they get wet and if they are not properly dried before storing mildew or mould sets in-untwist and smell-mildew can also be seen from outside deposited on the affected points.

(iii) Change in colour - Seen from outside-usually the colour changes to grey or bluish grey-untwist the strains to find out the damage.

12. **Testing of Lines**- Rescue lines should be tested monthly, after use at an incident and before use at a live rescue drill. One end of the line should be secured in such a way that any splices incorporated in it will be subjected to the test. Six men should take up positions spaced out at intervals of about five feet (1.52 M.) at free end of the line. When all are in position the front man should apply a steady pull until the line is being tested by the combined strength of all six men. This should be maintained for about 20 seconds and then, in succession, the men should release the load. The test should then be repeated with the line reversed. Each leg of lowering line with spliced legs should be tested separately. Guide lines should be tested in a similar manner except that the pull of only two men should be applied. On completion of the test the line should be minutely examined for any defect

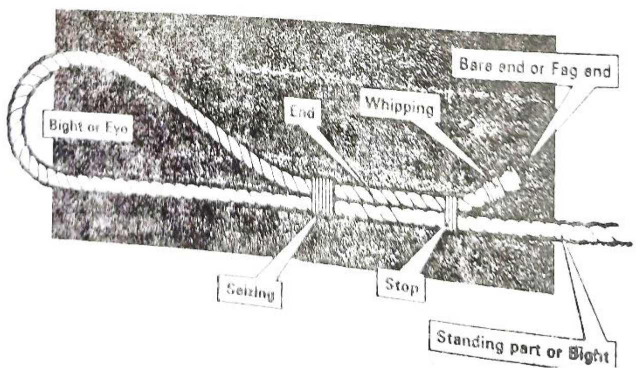
TERMINOLOGY CONNECTED WITH ROPES AND LASHINGS

13. Like most arts or practices knotting has a language of its own. Some of the important forms used are:-

(a) **Anchored**-Fastened to any immovable object like large tree, post or picket well driven into firm ground for this purpose.

(b) **Running end**-The free end of a rope with which the knot is made. Refer sketch below:
(c) **Standing part**-That part of the rope which is taking the load. Refer sketch below:-

(d) **Right**-An open loop of a rope. Refer sketch below:



(e) **Frapping**-The binding together of a rope or lashing between two poles.

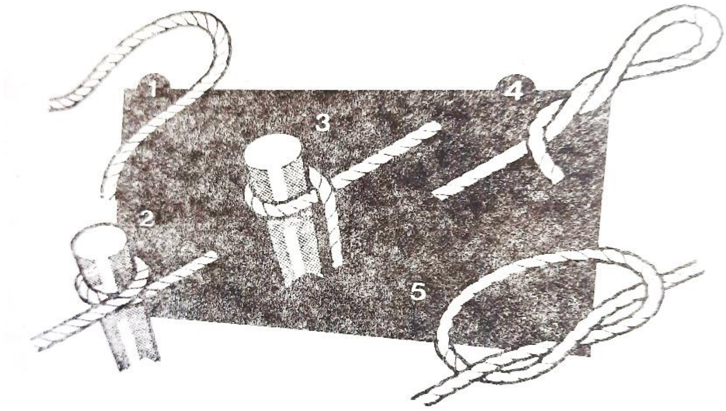
(f) **Haul**-The act of pulling on a rope

(g) **Hitch**-A loose loop on a rope. It means simple fastening of a rope around any object by winding and crossing one turn over another turn so that one bites on the other without actually knotting the rope.

(h) **Chaffing**-Catting/damage to rope.

(i) **Round Turn**-This is a complete turn of the rope round the spar or another rope.

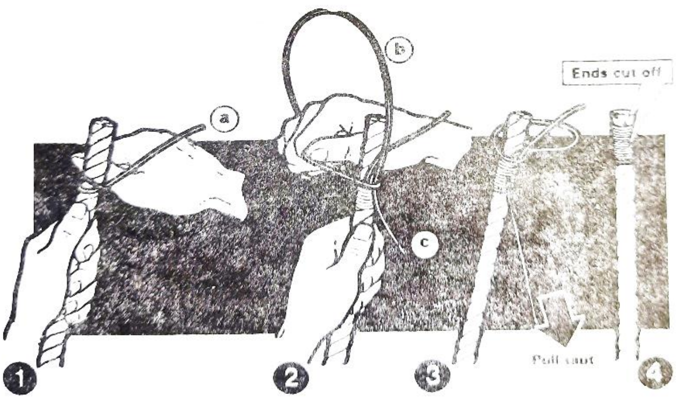
(j) **Parcelled**- When any rope or part of it is parcelled/wrapped to prevent chaffing it is called parcelled.



(k) **Paying out**-To ease off or slacken a rope.

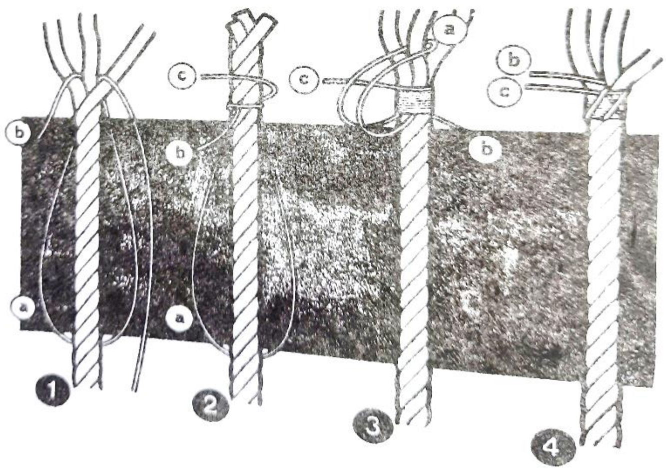
(l) **Reeve**-The act of threading of ropes through pulley or blocks.

(m) **Whipping**-Ropes should never be cut, as a rule. When it is cut as a mere necessity, its ends should be preserved. It is important that the ends of all ropes and lashings used in the rescue work are properly secured, from fraying and untwisting. This may be done, temporarily by a thumb knot a figure of eight knot or a back splice. Then such ropes look clumsy with unusually thick ends. For thicker ropes use back splice as this is much useful and superior. Whereas ends of ropes of lesser circumferences should be secured by whipping. There are many ways of whipping. The most common

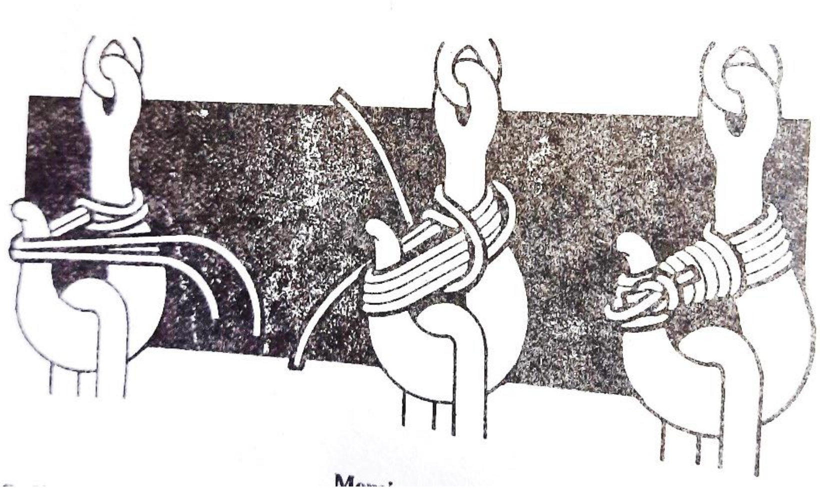


whipping used by rescue parties is the simplest to put on. Take a length of waxed seaming twine about 18 inches in length. Lay one end of this along the rope's end, hold it in place with the thumb. Now wind tightly the loose part of the twine round it and the ropes end. Carry on these turns until within half an inch of the bare end of the rope. Then lay back the other end of the twine, along the rope's end and take another four or five turns round it and the rope. Finally, the outer end of the twine is put inside the loop formed and the two ends of the twine are pulled and made taut.

The best and the most durable method of whipping is the method adopted by Sail Makers. Under this method the two ends of the twine is passed through the rope in such a way that a loop is formed and a strand of the rope remains within the loop. The loop and the ends of the twine are then adjusted in such a way that the lengths of the loop and the lower end of the twine become slightly more than the end position of the rope to be whipped. The round turns are then taken along the end of the rope going upwards with the larger end of the twine. When the end of the rope is reached, the loop is taken up along the direction of the twist of the strand which is within it and put around the strand. The loop is then made taut by pulling the lower end of the twine. Thereafter the same end is also taken up along the twist of a strand and putting over the free end of the rope it is brought to a position where it can meet the other end of the twine should be secured by whipping. There are many ways of whipping with which round turns were taken. A reef knot is then made inside the strands taking the ends and the spare ends of the twine are cut off.



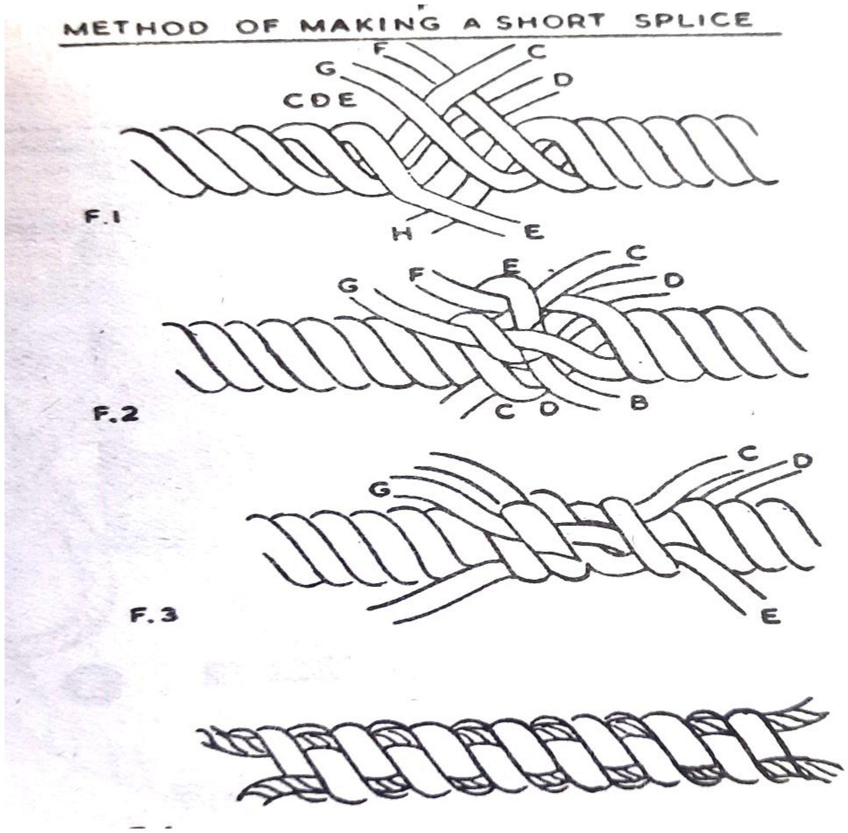
(n) Mousing -In rescue work when ropes are used along with blocks, many times the ropes are hitched and to prevent such a hitch from working up the hook, or to prevent on any occasion a hook from becoming unhooked, the hook is moused. Turns of yarn are passed round the bill and back of a hook and then knotted in a place. This is called 'mousing'. (Refer sketch below):



Mousing

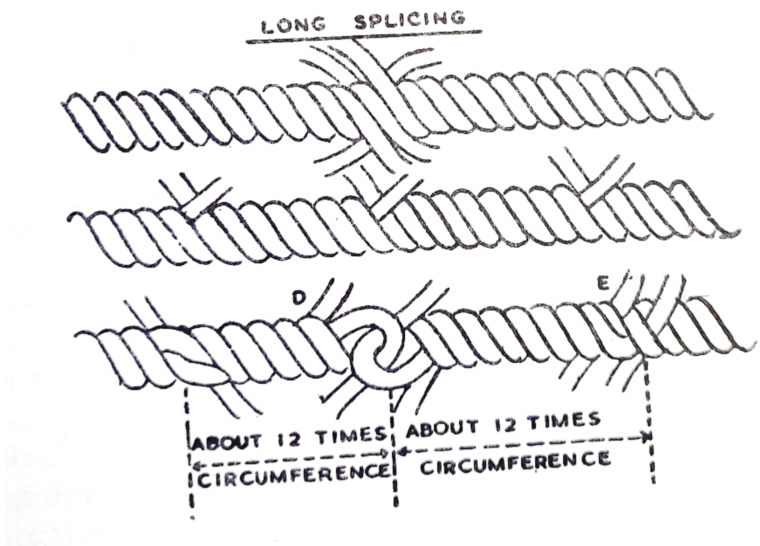
(o) **Splicing**- Splicing means to join rope by interweaving strands. Splicing differs from knotting. In splicing strands are interwoven, whereas in knotting the rope as a whole is used. Rope joined by splicing can pass through a block and splicing weakens the rope by 10 per cent only. Whereas rope joined by knotting cannot be passed through a block and its weakening effect is sometimes upto 50 per cent as in the case of reef knot and single sheet bend. Cordage and ropes sometimes require to be joined in such a way that there should be no substantial difference in their diameter and no weakening of their strength. This can only be done by splicing. No splice can be as strong as a rope of which it is made. However, a well made splice is stronger than a knot. The principles underlying all splicing work is that of interweaving of strands of a standing part in such a way that as soon as any strain comes upon either, the strands of the standing part will nip the interlocked loose ends and prevent them from drawing out. The tools required for splicing are few a knife for cutting and spike or 3 inch nail for opening the strands of the rope.

(i) **Short splice-**A short splice is used where there is not much strength required, and when there is not much time to make a long splice. To make a short splice, unlay the strands of each rope for a length of about 6 times the circumference of the rope. Marry the strands i.e. bring the ends together so that the separated ends fit into each other, one strand being in the space between two strands of the opposite rope. (See figure). The strands of the line (a) are then tucked into those of lines (b) and those of the line (b) into line (a) working all the time against the lay. Other figures show the other stages of a short splice. If the rope has to pass through a block this splice is unsuitable and a long splice must be used.



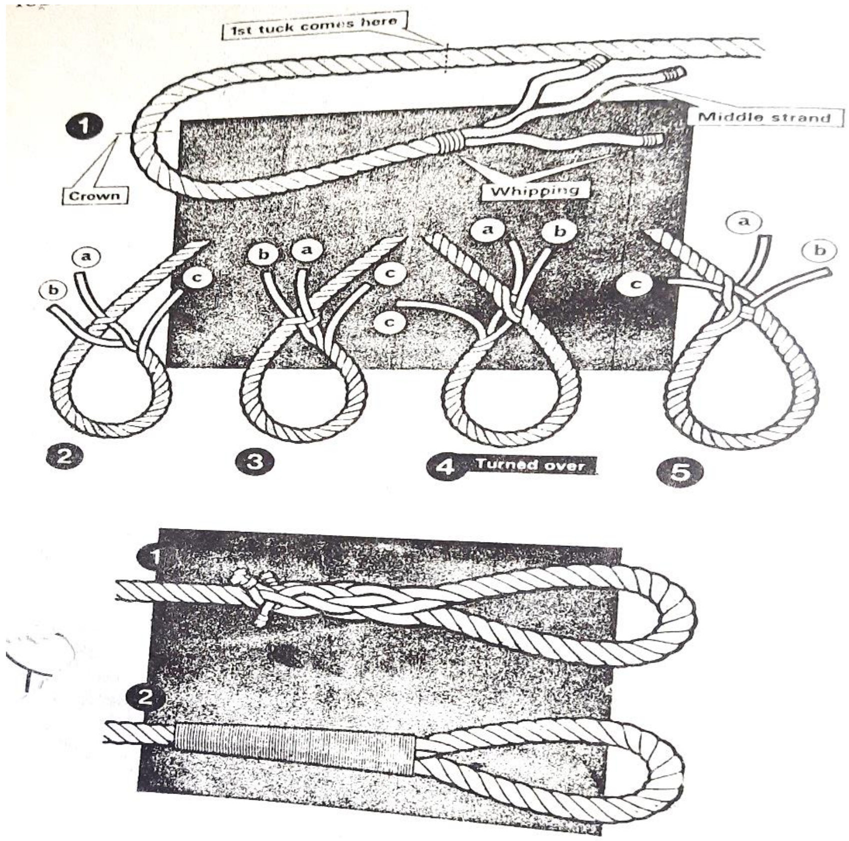
Short Splice

(ii) **Long splice**- This splice is stronger than the short splice, but uses more rope and has the y advantage of not increasing the thickness of the rope. For three stranded rope, the minimum length of rope unlaid should be 6-7 times that of the circumference of the rope and for the four stranded rope 10 times the circumference. For normal use, in making a long splice unlay the ends of both the ropes for a length 12-14 times the circumference. Marry them as for short splice. Without disturbing them strands, choose one strand and begin to unlay it, filling up the room it leaves with the corresponding strand of the other rope, working to within a few inches of its end.



Repeat with another pair of ads but working the opposite way. Let the remaining strand stay Put The ends of the strands now have to be locked as shown in the figures (c), (d) and (e) A long splice should be well stretched and rolled before the ends of the strands are finally cut off.

(iii) **Eye splice**-This is used in rescue work most frequently. It is used for making an eye in a rope round times or block and is formed by unlaying the end of a rope for short



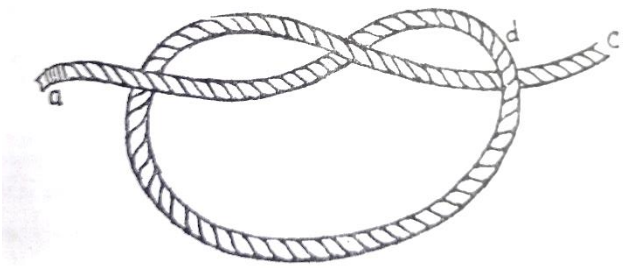
distance and then interweaving the three unlaid ends, with the standing part so as to form the size of eye required. To make an eye splice in three stranded rope unlay the strands for a short distance and bend the rope to form an eye, placing two end strands across at right angle to the lay of the standing part of the rope and the other strand behind (a). Then take the centre strand under the nearest strand of the standing part (b) under the remaining strand of the standing part, going in where the first strand, comes out (d). You now have an end strand projecting from each space of the standing part (e) With this the first tuck is over. Take the first end strand under the next strand going in where the second strand comes out (c). Turn the rope over and tuck the third strand. Tuck each strand in turn over and under one and make two tucks and two tapper tucks. An eye splice is valuable on the end of rope e.g. when erecting blocks and tackles on sheer legs, if the straps or slings have eye spliced ends, it is simply necessary to pass hook of the tackle through the eye and save much time. Stretcher slings can be made from two short pieces of rope with spliced eyes at each end. All that is required is that they have to be placed over the ends of the stretcher. This saves time and labour and increases efficiency, which is important in rescue operations.

(iv) **Running splice**-This means replacing a damaged or chaffed strand in a rope, by inserting a fresh strand. This enables the rope to be passed through the block and the rope is almost normal. The strand for repairs should preferably be taken from one end of the rope as this makes the job easy.

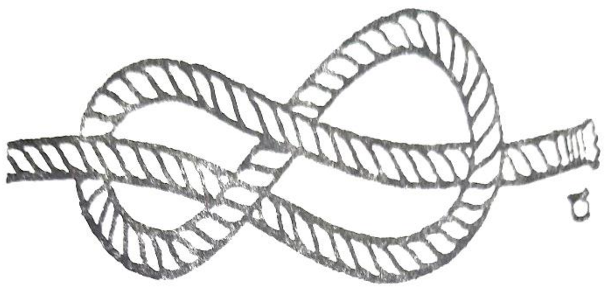
14. **Knots and Lashings**- Rescue Party personnel should be familiar with ropes, knots and lashings and with constant practice must learn how to make and adopt them with speed and proficiency. Details of various types of knots and lashings are given in subsequent paras.

KNOTS

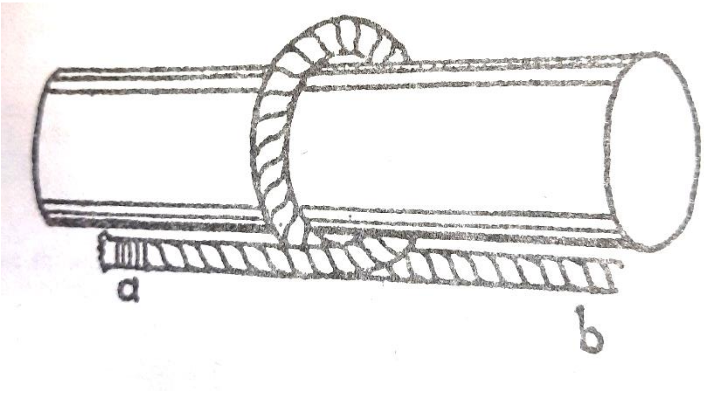
15. (a) **Thumb knot**-This is a simple knot tied in the end of a rope to stop the rope passing through a pulling block or temporarily to prevent fraying of an end. The knot is formed by making a loop and passing one end through it.



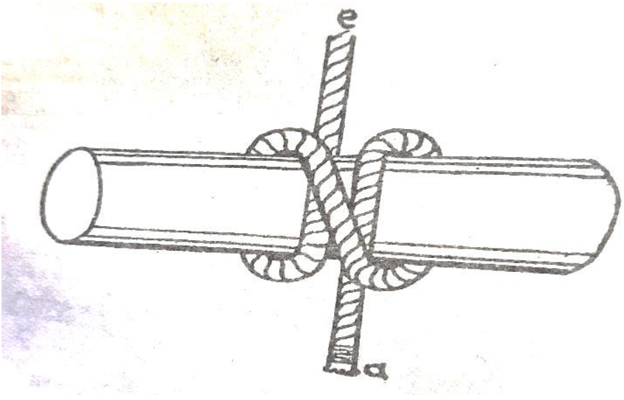
(b) **Figure-of-eight knot**-With the rope "away" from you, take the standing part in the left hand palm upwards and the running end in the right hand. Pass the running end over the top of the standing part making a loop, then carry on with the running end round behind the standing part, over the top. then down through the loop which you have formed. Draw the running end tight and the knot should resemble the Figure of 8. This knot is useful as a stop and is often used to prevent the end of a rope from running further through a block. It can also be used temporarily to prevent the end of a rope from fraying when the whipping has been lost. In general it is more useful than the Thumb Knot as it is easier to undo.



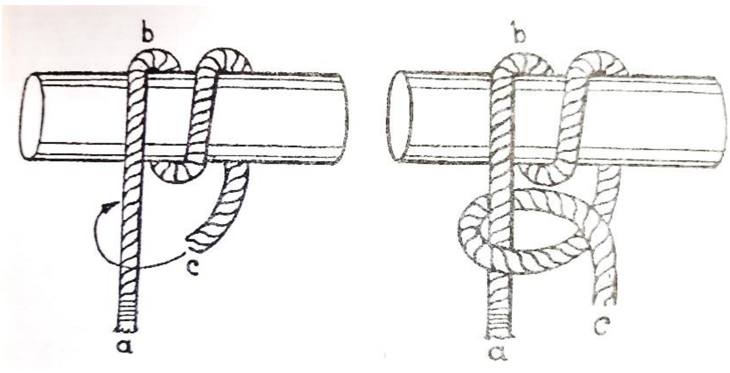
(c) **Half-Hitch**-This is formed by passing the short end of a rope around the spar (or around rope) and under the standing part, so that, when pulled, one part of the rope binds the other.



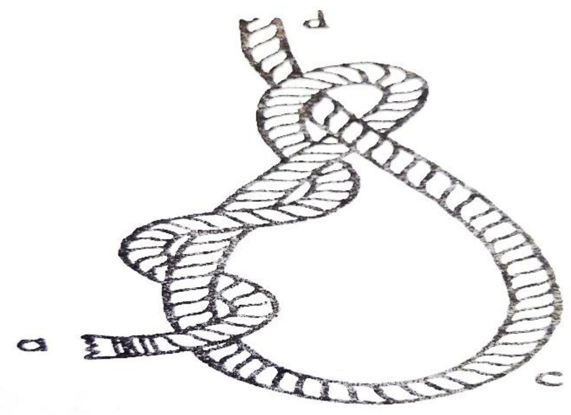
(d**) Clove Hitch**-This forms the basis of many securing knots and can be used at the end of a rope or in the centre. To tie at the end of a rope, pass the running end round a pole bringing it out underneath the standing rope. Pass the running end round the pole again above the first half hitch, bringing the running end under itself to tighten, pulling both the running end and the standing rope. When tied thus at the end of a rope, it is a good anchoring knot and is easily untied. To tie in the centre of a rope, two loops are formed, one in the left hand (anti-clockwise) and one in the right hand (anti-clockwise), the latter being passed in front of the left hand loop. Both loops are then passed over the pole and drawn right.



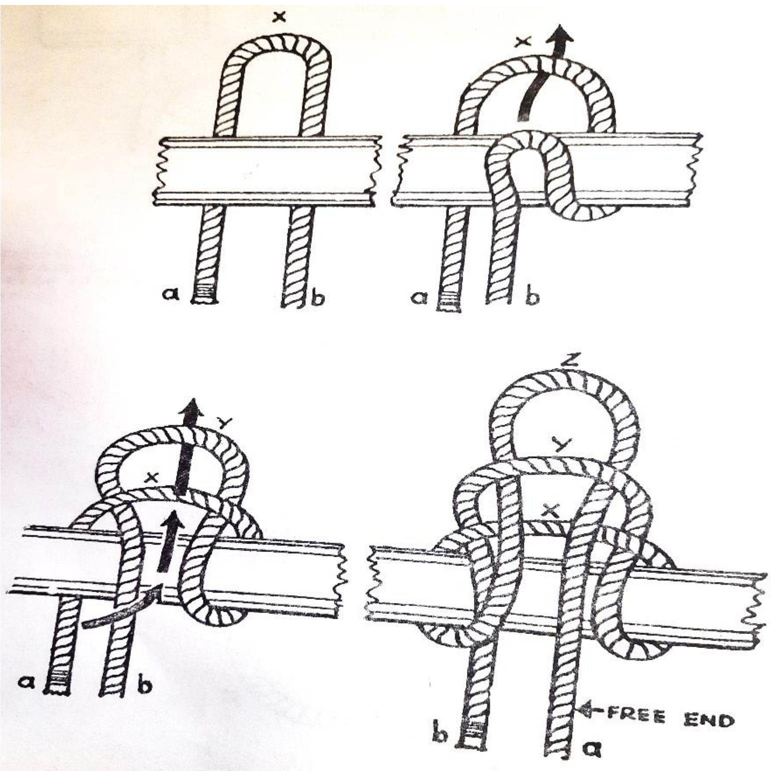
(e) **Round Turn and Two Half Hitches**- This also is used for securing a rope to a spar or ring and is formed by round tum on the spar or ring with two half hitches on the standing part of the rope.



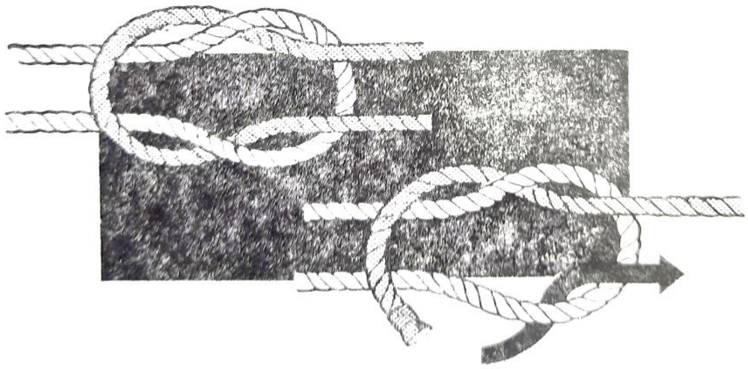
(f) **Timber Hitch**-This is quickly made temporary knot used to secure a rope to a plank or pole, and is formed by making a half hitch on the standing part of the rope, leaving a long end which is twisted back again around its own part of the hitch. When used for lifting spars, planks or poles, this hitch should be used in conjunction with a half hitch at the upper end of the spar.



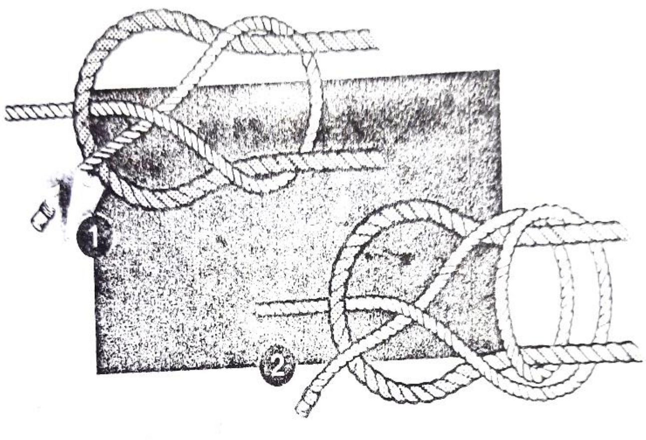
(g) **Draw Hitch**-This hitch will stand a considerable strain on the standing part and yet can be easily released by jerking the free end. It enables the rope to be recovered from places where the knot cannot be reached and untied by hand. e.g. where the rope has been used by a person to lower himself from a height. It is formed as follows: a bight is passed around the spar and a second bight, which is then formed on and passed through the second bight and the whole tightened up by pulling on the standing part. The bights should be tightened as much as possible at each stage. The draw hitch is not considered reliable when used on a square holding but is quite satisfactory on a round spar or ring.



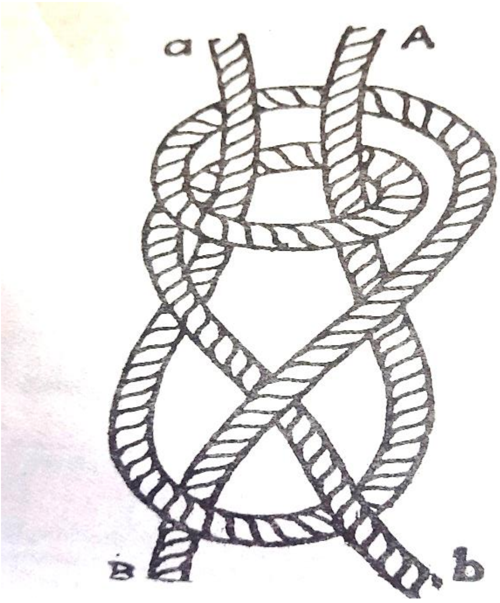
(h**) Reef Knot-** For joining two ropes of equal thickness. This is best described as two thumb knots tied in reverse direction, left over right then right over left. It is quickly untied and is a useful knot for general purposes. It should be used for all bandaging and for tying two dry ropes of the same size when the pull is constant. A reef knot can be tied and will remain tied when there is an initial pull on the ropes.



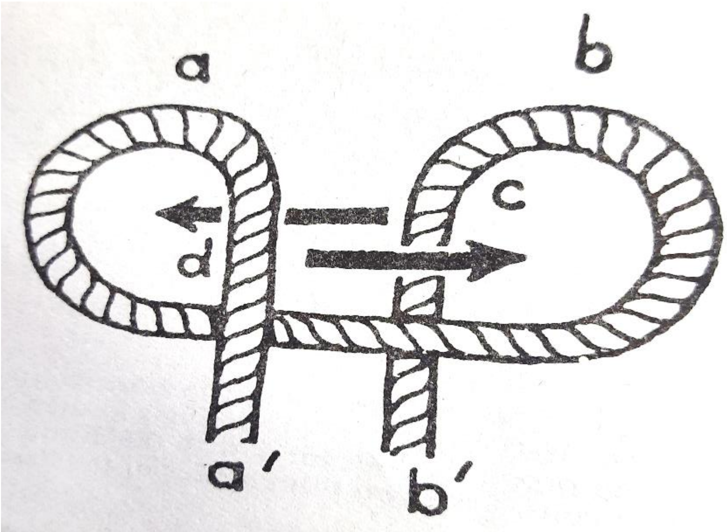
(i) **Single sheet bead**-There are two types of Sheet Bend, the Single Sheet Bend and the Double Sheet Bend. Both are used for uniting two ropes of different thickness and have the advantage that they do not slip when the rope is wet. The Single Sheet Bend is formed by making a loop in the thicker of the two ropes and holding this in the left hand, the end of the thicker rope is passed upwards through the loop forming a half hitch round the two thicknesses of the thicker rope.



(j) **Double sheet bend-** The Double Sheet Bend is trifle more secure than the Single Sheet Bend and is used when there is great difference in the size of the ropes. It is formed in a manner similar to the Single Sheet Bend except that after having made the half hitch with the thinner rope, continue turning its short end to make another round turn around the two thicknesses of the thick rope and towards the bight.



(k) **Chair knot**-The chair knot is a good general purpose knot and one which is very important for emergency rescue work. One of its main purposes is to form an efficient and quickly made sling in which a person may readily be raised or lowered. The sling formed by this knot gives support to the chest and legs of the person being rescued. It is formed by grasping the rope, near its centre, in the left hand palm down. Approximately a yard from the left hand take the rope in the right hand palm uppermost. Turn the left hand palm upwards forming a loop (anti-clockwise), turn the right hand palm down forming a loop. Pass the standing ropes through the loops of the opposite hand pulling them through, thus forming two loops with a knot in the centre. These loops can be adjusted to the required size. A half hitch is then made on each loop to keep at their required size. One loop will be slightly larger than the other to keep the person being raised or lowered in a "Chaired" position. To place the person properly in the knot the small loop must go under the armpits, and the longer loop at the back of the knees. When properly fixed in this knot and slung the person cannot get out however much he may struggle. At the same time no undue pressure is caused upon his body.

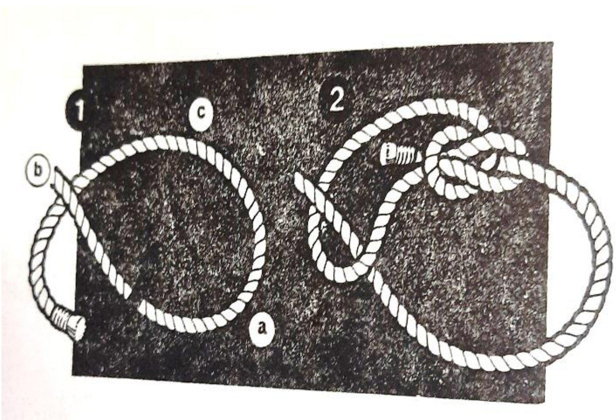


(l) **Bowline**-There are several methods of making a bowline, but the simplest and quickest is as follows: the standing part (a) of the line is held in the left hand and the running end (b) in the right. The running end is then laid across the standing part and a half hitch (c) formed round it by twisting the standing part with the right hand. The knot will then appear as shown below.

The half hitch (c) is now secured against the standing part (a) by passing the running end (b) behind the standing part and back down through the half hitch (c). The knot is then drawn taut

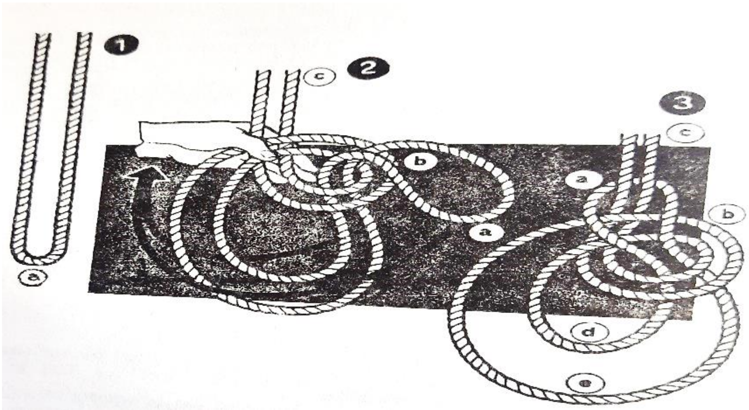
The bowline forms a non-slipping noose and is useful for lowering or raising purposes, and can also be used to make a temporary eye in lines of all sizes. Another purpose of the bowline is to attach a line round the waist when it is necessary to trail a line, and every fireman should be able to tie a bowline round his own waist with his eyes closed:

(i) **Running bowline-**A running bowline (shown below) is made by forming a bight (a) in the end of the line by passing the end of the line under the standing part (b) A bowline is then made with the end at the point (c) on the bight so formed thus making a running noose.

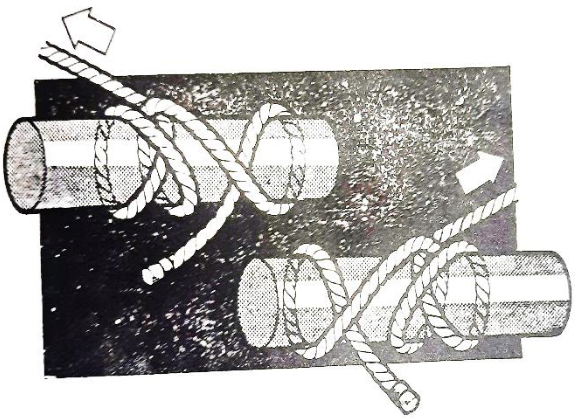


A running bowline can be put on a ring bolt, spar or other object, the ends of which are secured so that the noose cannot be slipped over, by passing the line round the object, leading it under the standing part and back, and then tying a bowline on the loop so formed. A running bowline should never be placed round a person's body.

(ii) **Bowline on the bight**-A bowline on the bight is first formed by making a bight (a) in the end, or centre, of the line. The bight is then used in the same way as the free end is used when making an ordinary bowline, and a half hitch (b) is formed on the standing parts (c) of the line. The part of the bight (a) which has been passed through the half hitch is then opened out, and taken in the direction indicated by the arrow (i.e. behind the remainder of the knot) and brought up to the two standing parts (c). The knot is then hauled taut.



This knot is used as a sling for rescue purpose. For this the two bights (d) and (e) which are formed are passed one under the knees and the other under the armpits of the person to be rescued. The knot should be made so that the loop to go round the body is somewhat smaller than the loop for the legs. The respective lengths can be adjusted as required by slackening the knot and pulling the loops to the desired size.

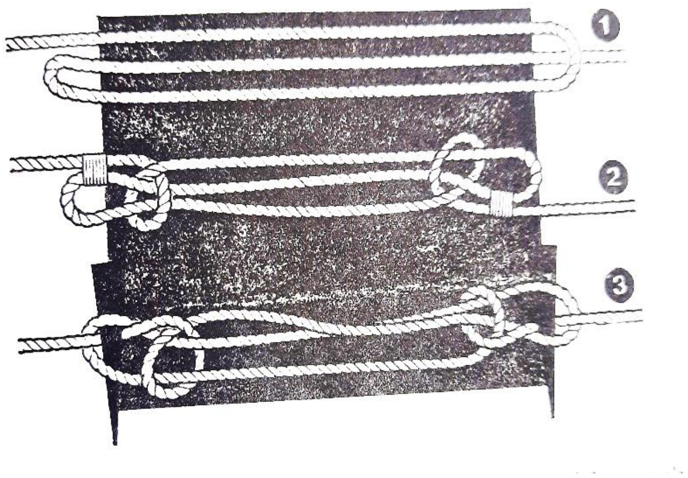


Rolling Hitch

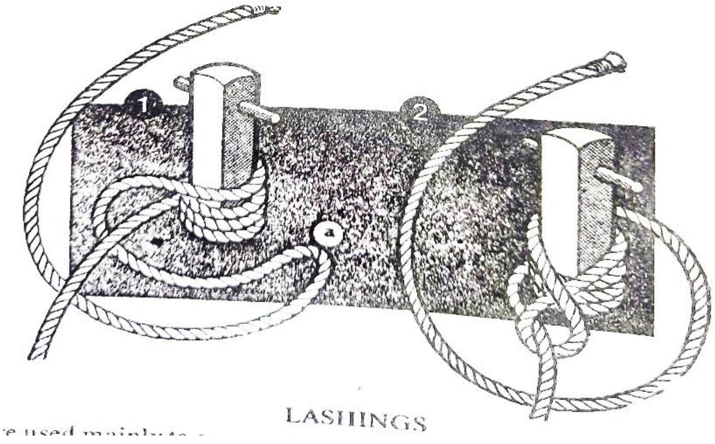
(m) **Rolling hitch**-The rolling hitch is a variant of the clove hitch and is started and finished in the same manner, but as intermediate round turn is made between the two half hitches; this inter mediate round turn passes over the standing part. This knot has the advantage that it will not slip in the direction in which the double turn is applied if it is subjected to a sideways pull. When tying a rolling hitch it must be constructed for the specific strain which has to resist. Rolling hitches made to take to the left and to the right are shown. No difficulty should be experienced in tying the knot correctly if it is remembered that the round turn should be made on the same side of the standing part as that on which the strain is to be applied, i.e. if the strain is to the left, then the round turn should be made on the left of the standing part and vice versa.

(n) **Fisherman's bend**-The fisherman's bend is an alternative to the round turn and two half hitches, and is made by forming a round turn on the spar or other line to be secured, then making a half hitch round the standing part in such a way that it passes through the round turn. A further half hitch is then made with the end on the standing part. The end should be stopped to the standing part. This knot, like the round turn and two half hitches, is used to secure a line to spar or to another. It is more generally used by fireboat crews to secure a line to a ring bolt.

(o) **Sheepshank**-A sheepshank is used to shorten the bight of a line temporarily without cutting it. It is made by gathering up the amount of line by which it is desired to shorten the line as shown below. Half hitches are then placed around the ends of each bight.

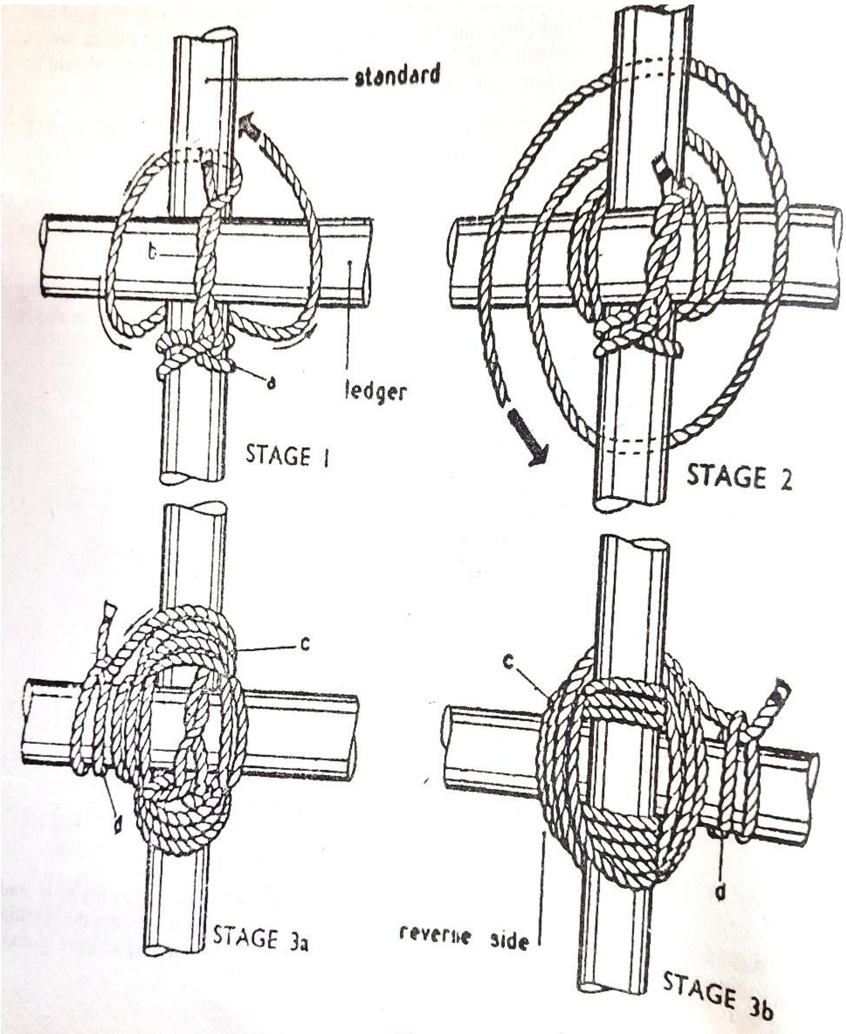


(p) **Waterman's hitch**-The waterman's hitch (sometimes called the lighterman's hitch) is made by taking several turns round a bollard or bitt, passing the running end over and under the standing part and then pulling out a bight (a) which is dropped over the bollard, thus forming a figure of eight. The line is then hauled taut. Fireboat crews generally use the waterman's hitch to secure a skiff to the towing bit of a fireboat. Its virtue is that it can both be made and cast off when under a strain on the standing part.



LASHINGS

16. Lashings are used mainly to secure two or more poles firmly together. It may be made by using 40 ft. x 1½ lashings carried by rescue party. There are four types of lashings as under:-



(a) **Square lashing**-This is used to lash together two poles that touch and cross at right angles. The stages of lashing are shown below:

(i) **Stage 1**-Start with a clove hitch (a) round the standard below the ledger. "marrying" the ends at (b). Take the "married" ends up and around both standard and ledger as depicted by arrows.

(ii) **Stage 2**- Repeat this circuit three or four times, drawing the rope as taut as possible.

(iii) **Stage 3a**- Take three or four frapping turns (c) around the whole lashing between the spars, draw taut and finish with a clove hitch (d) on the ledger or on the standard above the ledger.

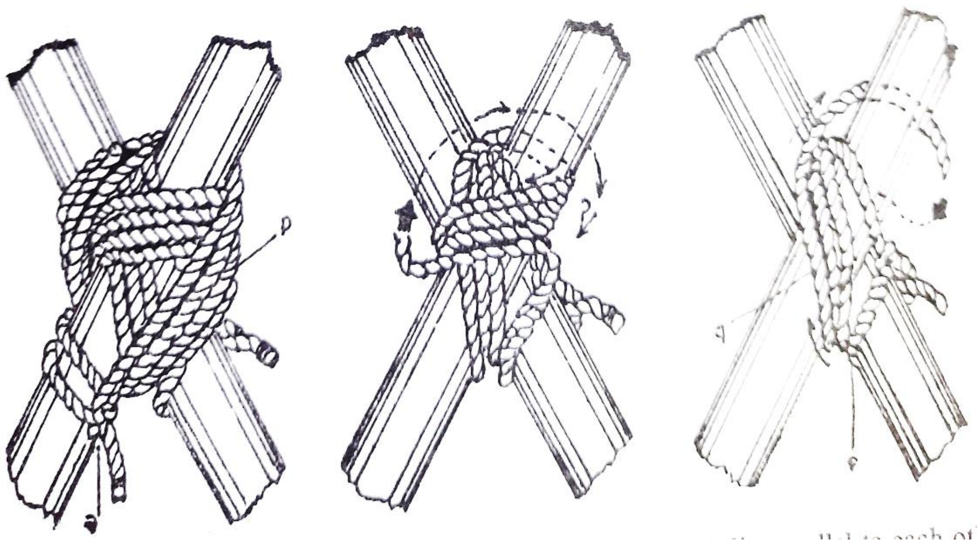
(iv) **Stage 3b**-The square lashing complete as viewed from the back.

(b) **Diagonal lashing-** This is used to lash together two touching poles at an angle especially within their mode of use may cause them to spring apart. This is carried out in three stages:

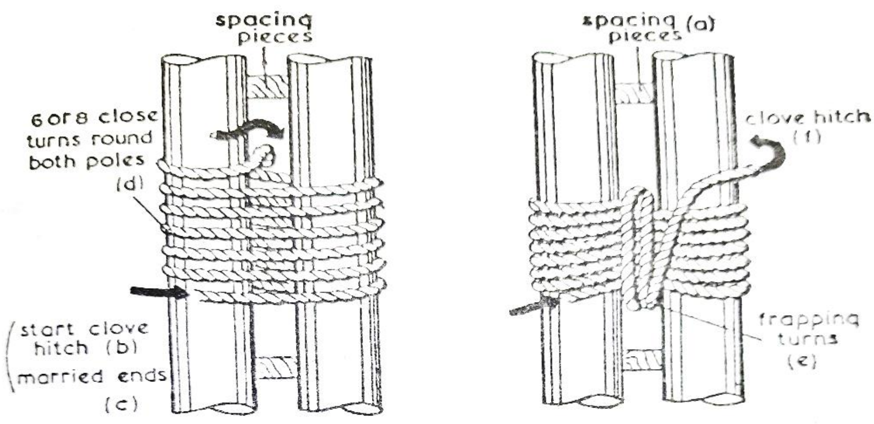
(i) **Stage 1**-Start with a timber hitch (a) round both poles horizontally, then take front vertical turns (b) and draw all taut.

(ii) **Stage 2**-Take four horizontal turns (c) and draw taut.

(iii) **Stage 3-** Finally, put your frapping turns (d) over the lashing, between the spar, draw well taut, and finish with a clove hitch (e).

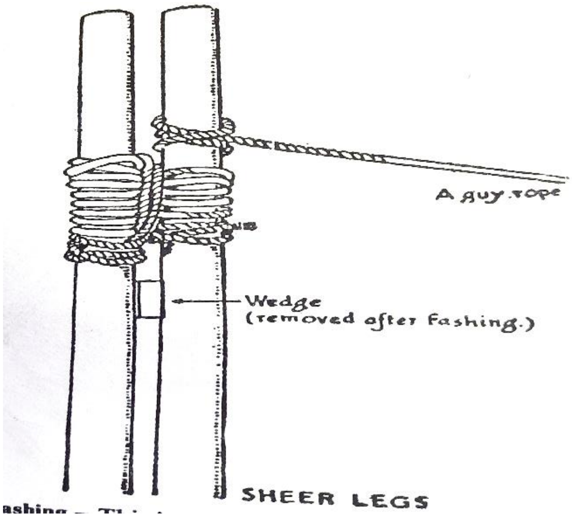


(c) **Round lashing**- This is used to lash together two poles which lie parallel to each other. It is

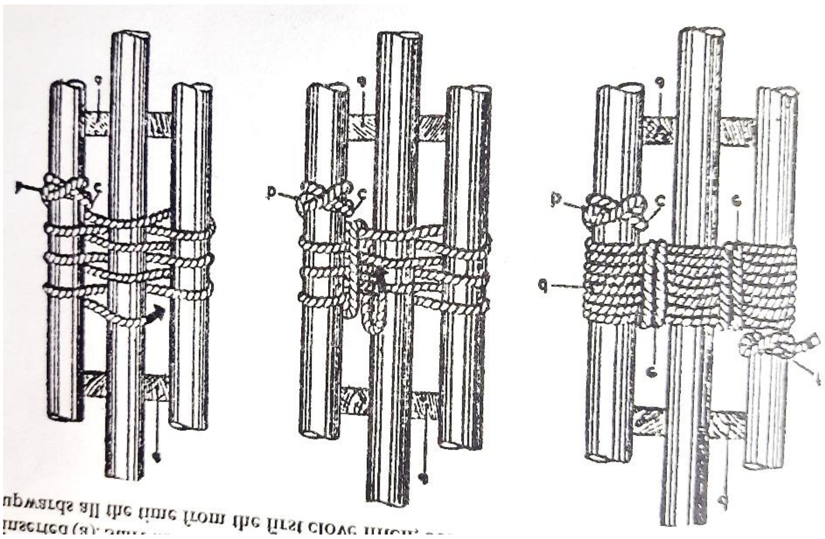


Round lashing-

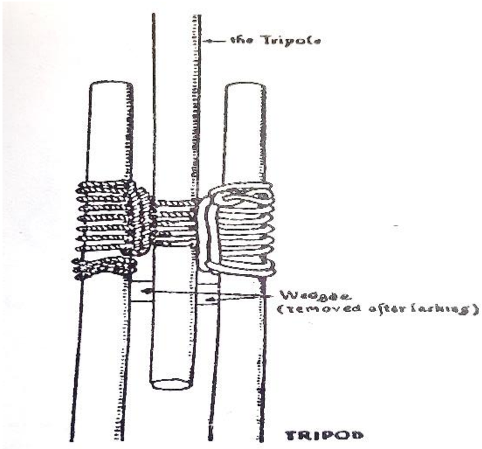
carried out as per the following steps. Before starting insert spacers between the poles. The thickness of the spacers should be approximately half the diameter of the poles. Put a clove bitch around one pole, marry the ends and continue with 6-8 close turns round both the poles going upwards. Add two or three frapping turns round the lashing and between the poles End with a clove hitch above and on the opposite pole to the starting pole.



(d) **Figure of Eight lashing**-This is used to lash three parallel poles together, as may be necessary to form a tripod or gyn. Spacing pieces, approximately half the diameter of the spars, should be inserted (a). Start with a clove hitch (b) round one of the poles, with the end "married", Working upwards all the time from the first clove hitch, continue lashing in figure of eight fashion with



6-8 turns (e). Make two to three frapping turns (d) round the lashing, repeat at (e). Finish with a clove hitch (0 on the opposite pole to the beginning of the lashing.



LASHINGS FOR A TRIPOD

SLINGS

17. **General-** For slinging heavy loads to be lifted by apparatus set up by rescue parties, chains and wire slings are carried on company equipment vehicles.

18. **Chain slings**-The chain slings supplied are of the single leg type with a hook at one end and a ring at the other, and are rated at a safe working load of 1000 kg.

19. **To lift a load with a chain sling**-The following methods may be adopted:-

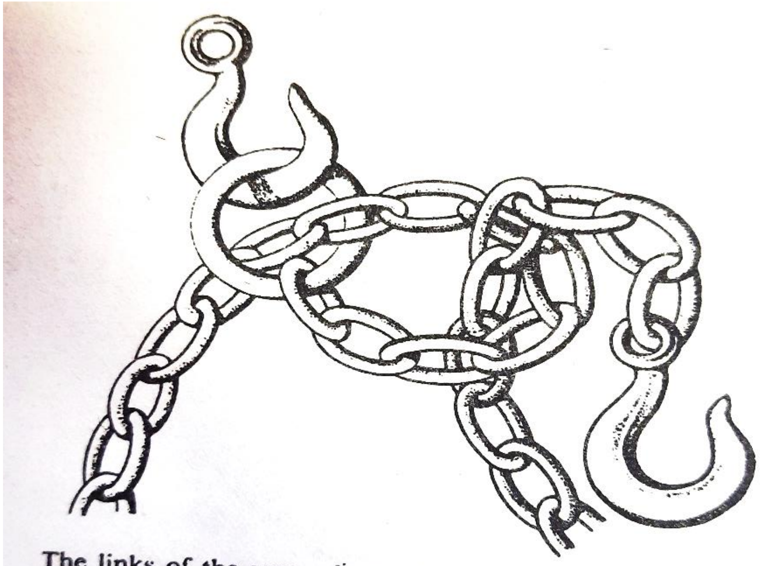
(a) The ring of the sling can be placed on the hook of the lifting tackle and the sling hook placed in the ring, or

(b) The ring of the sling can be placed on the hook of the lifting tackle and the sling hook placed around the chain after passing the chain around the article to be slung. When the latter method is used, the bight should be forced down as low as possible to ensure a firm grip on the load.

20. **Shortening a chain sling**-Chain slings should never be shortened by tying a knot in the chain as this will cause excessive bending stresses in some of the links and may result in damage or fracture. If it is necessary to shorten a chain sling the method shown in Fig. below should be adopted.

The links of the upward and downward passing parts of the chain interlock in the ring

21. **Wire rope slings-**Wire rope slings supplied with rescue equipment are of the single leg type capable of dealing with loads up to 1000 kg. They are lighter in weight than chain slings of equal 5.W.L. but are more susceptible to accidental damage and require greater care in use.



The links of the upward and downward passing parts of the chain interlock in the ring

22. **General precautions in use of slings**- The method of slinging any given object must vary according to circumstances, but certain general rules and precautions should be observed to ensure safe working

(a) The size, and therefore the strength of the sling selected, will be governed by the weight of the load. (For estimating loads likely to be met with see Appendix K).

(b) The efficient use of a sling is governed by the angle between the legs of the sling or the position in which it is used.

(c) Timber packing must be inserted between the sling and the edges of the load to prevent the
sling coming in contact with sharp edges.

(d) Hooks must be moused.

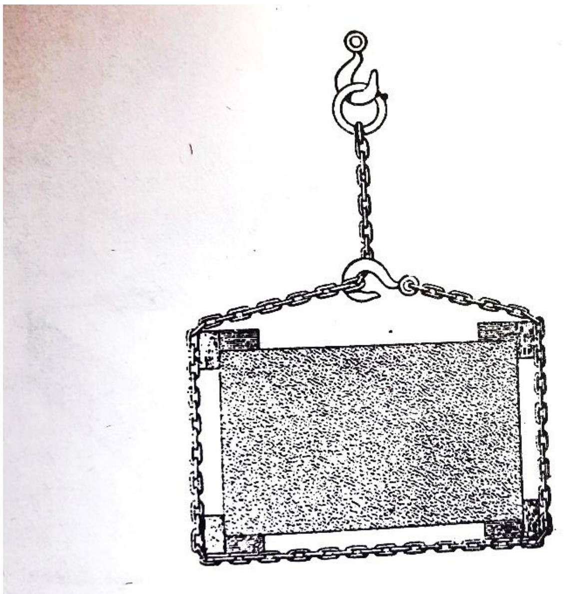
(e) Wire rope slings must not be bent round too sharp an angle and, to prevent this, timber packing must be used to ensure an even curve.

(f) The shackle of a wire rope sling must not be placed around the sling to provide a bight.

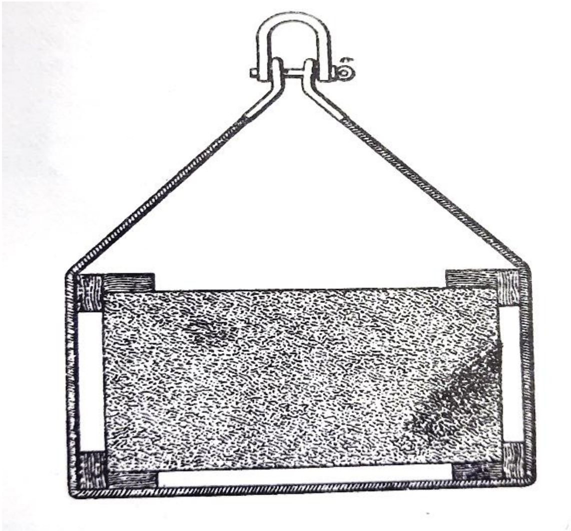
(g) Carelessness in hoisting, e.g. shock lifting or snatching, must be avoided.

(h) Slings should not be dragged along a floor or the ground, and should never be pulled from
under a load which, when lowered, is resting on the sling.

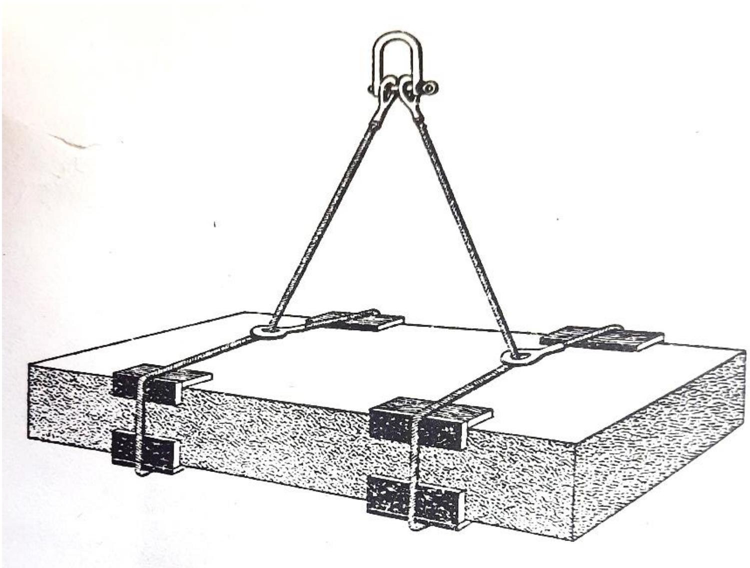
23. **Methods of slinging**-In the event of being unable to obtain the necessary chain or wire rope sling, the rescue man should be able to improvise by using the 40 ft. lashing line.



Single chain sling reeved round a load, with bight forced down close to load



wire rope sling with ordinary thimbles at both ends secured by shackle and pin after being reeved round a load



Two slings in use (chain or reeved wire sling) Horizontal distance between points of attachment to load should not exceed the free length of sling deg.

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CHAPTER 10

LADDERS FOR RESCUE WORK

1. **Introduction-** Ladders are emergency equipment and play an important part in rescue operations. The members of Civil Defence rescue parties must therefore be fully acquainted with their construction and handling. Ability to carry, raise, climb, and handle ladders quickly, safely and proficiently is an indicator of a well-trained rescuer. Apart from speedy work this proficiency leads to freedom from accidents and supplements efficiency,

TERMINOLOGY

2. The following terms are commonly used in connection with ladders:-

(a) **Ladder**-A piece of equipment which may be made of wood/bamboo/aluminium/rope ladder and used for climbing.

(b) **Beams**-These are the sides of the ladder, this is also called sides or strings.

(c) **Rung**-These are crossbars meant for assisting in climbing. They may be made of wood. bamboo. metal or rope,

(d) **Short Ladders**-A ladder which is long.

(e**) Extension Ladder**-A ladder built in sections.

(f) **Bed**-Lower section of an Extension Ladder.

(g) **Fly**-Upper section of an Extension Ladder.

(h) **Heel/Butt**-Bottom or ground end of a ladder.

(i) **Top/Tip**- Top of the ladder.

(j) **Heel Plate-** Metal at heel of the ladder.

(k) **Fly rope**-Rope used to hoist fly.

(l) **Pulley**-Small grooved wheel through which fly rope is drawn.

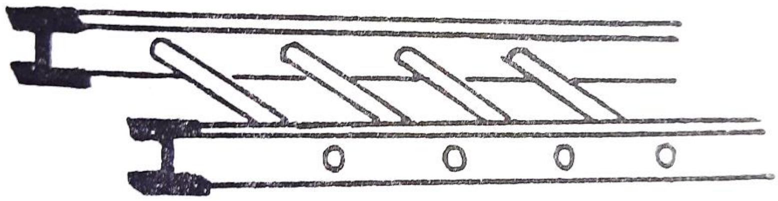
(m) **Pawl or Dog**- The mechanism on the lower end of the fly ladder that secures it to the bed ladder and holds the rungs at desired elevation.

(n) **Straight Ladders**-This is also called walled ladder. It consists of one section only.

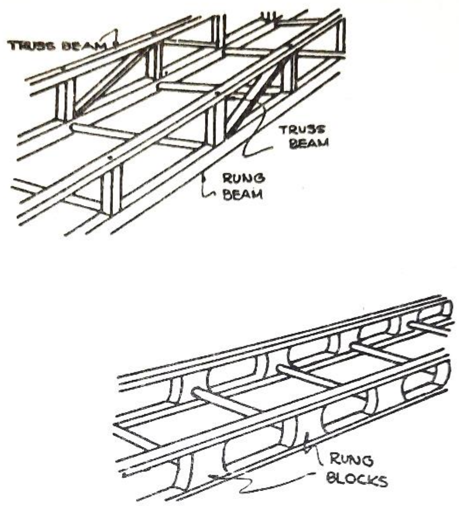
(o) **Hook Ladder**- Also known as roof ladder. These types of ladders have hooks mounted on a socket.

DESIGN AND TYPES OF LADDERS

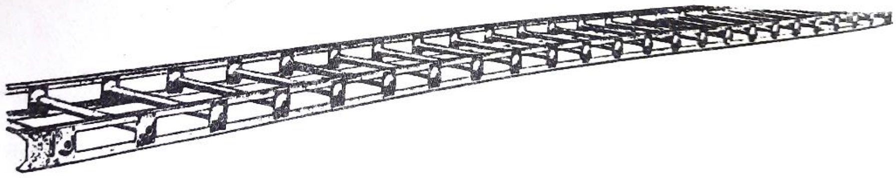
3. **General-** Seemingly the matter of "ladder design" would be of concern only to the manufacturers, yet wide-awake rescuers should know the details of construction in order to use a ladder efficiently and safely. The principal parts of a ladder are the sides, called beams, and the rungs. The rungs are of similar design consisting of a round bar of a size to provide the required strength and to be easily grasped. Metal rungs may be fluted horizontally to provide surer grip and footing.



Ladder beams are either solid or trussed. As the name suggests, the solid beam is a solid piece of material of such shape and size to provide the required strength. The rungs are set in at the centre of the solid beam. Trussed construction is employed in the larger sizes to make ladders stronger.



Trussed ladders



Straight Ladder

4. With advancement in technology aluminium alloy ladders have come in to general use in rescue service. They are of light weight and when constructed as three section ladders, a 45 to 50' length may be achieved.

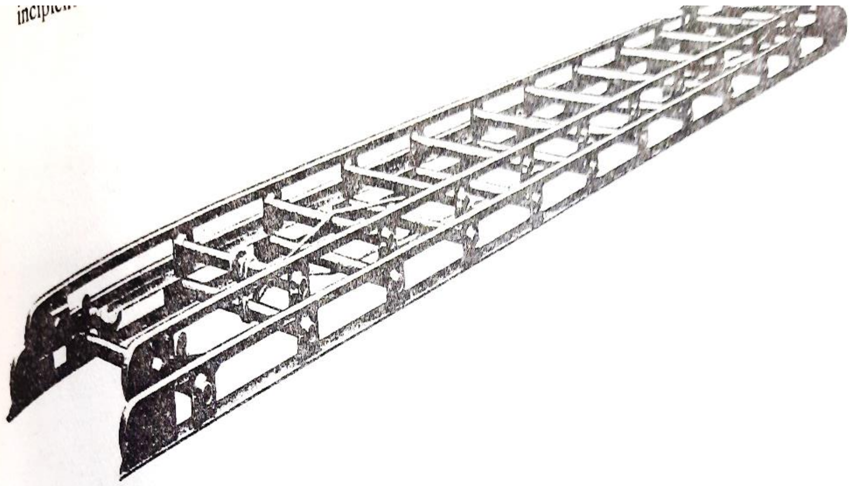
TYPES OF LADDERS

5. (a**) Short Ladders-**The types of short ladders used by the Rescue Parties are of 8 to 10 feet in length. Two short ladders each 8 feet long coupled together form a ladder approximately 13 feet long. A ladder of this size can reach first-floor windows of most dwelling houses and also into basements, and will prove valuable when making a reconnaissance. These short ladders may also be employed when getting over obstacles, damaged walls, gaps and so on. For bridging a gap, ladders can be used by placing one (or two side by side) over the opening (reinforcement if any, on the underside) and laying a board or boards flat on the rings. Wherever possible, one length of board should be used on one ladder, but if this is not practicable, care must be taken to overlap the ends of the boards where they meet in such a way that the rescuer will not trip when carrying a casualty. The ladder or ladders must be long enough to bridge the gap and to have adequate support at either end.

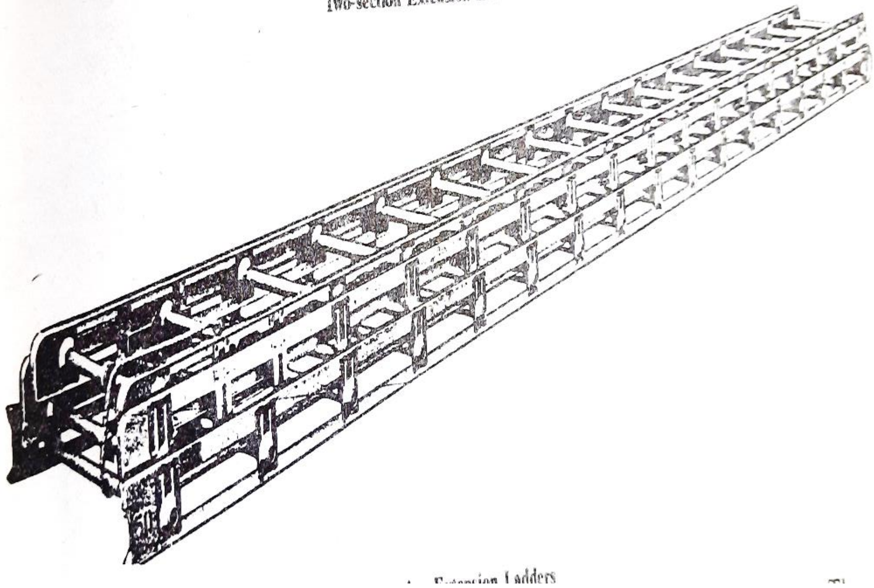
(b) **Bamboo or Wooden Ladders**- These are ordinary bamboo/wooden ladders of 20 feet in length. In emergency, two such ladders can be lashed together with an overlapping of 3 feet to give a maximum length of 35 feet. A 15 feet long ladder also can be used instead.

(c) **Straight Ladders**-Sometimes called "wall ladder of one section only, are made both solid beam and trussed, and in standard lengths ranging from 10 to 28 feet. Few of 30 or more feet in length are in use.

(d) **Extension Ladders**-These ladders are generally made of two/three sections with length ranging from 14' to 100'. However, the normal issue to a rescue party is the 15' extension ladder which is in two sections, the upper section sliding on and between the sides of the lower section. Pawls are fitted to the lower end of the sliding section and operate on a rotating shaft; pulling lines are taken through sheaves fixed near the top of each string of the lower section, brought down and fastened to hooks or cleats at the bottom of this ladder, one cleat being attached to the pawl shaft, thus providing endless lines by means of which the top section can be extended, and the pawls which are mounted on the sliding can be engaged and tripped or released. The metal tongues fitted to the top section of the lad der slides into grooves cut in the strings of the bottom section. To make it easily distinguishable in the dark the strings of the bottom section should bear a white line to indicate the "limit of safety when extended for use-the of the ladders is normally five rungs. Similarly, the "bottom" of the ladder should a 6-inch band of white paint. The ladder is strengthened on the underside of all strings by galvanised wire which is stretched tautly in the groove along the edge of the strings, being secured at the top and bottom and kept in position by staples. The ladders are further strengthened by cross-ties of wrought iron rod from string to string at intervals. Ladders should not be painted as paint would hide incipient defects. Clear varnish or treating the bare wood with linseed oil usually proves satisfactory.

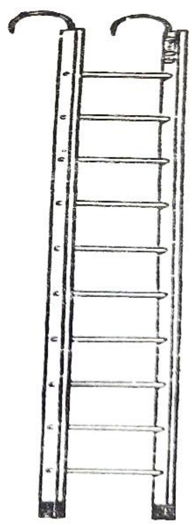


Two-section Extension Ladders



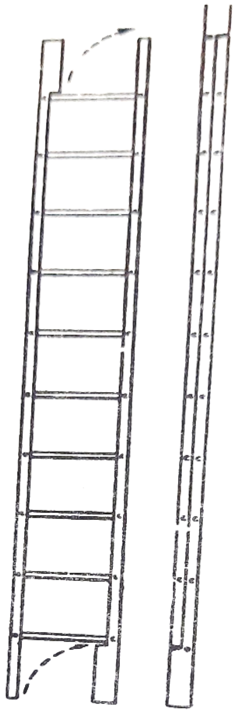
Three section Extension Ladders

(e) **Hook Ladder/Roof Ladder-** It is an adaptation of the wall ladder to a special purpose. There are several types of roof ladders, most of which have the hooks mounted on a movable socket which permits them to fold inward when not in use. A few old roof ladders with rigid hooks are still in use. The roof-ladder is employed in getting to peaks of gabled roofs to permit rescuers to cut holes for ventilation. It can also be used to good advantage in entering scuttle-holes of holes cut through flooring and sidewalk openings. The books of the ladder may be placed over roof peaks, sills, walls or coping to secure the top of the ladder. Hooks may be set so that they do not protrude beyond the ladder beams thus permitting the ladder to be used as a wall ladder, Other uses are as an improvised "pompier or scaling ladder, as an "improvised cellar pipe as part of the framework for an emergency suction basin and as an improvised nozzle holder. Roof ladders of the book type range in lengths of 10 to 20 feet. They may be either the solid beam or the truss beam type. The ladder may also have a single hook fitted to the top rung in the centre.



Wood roof ladder

(f) **Collapsible Attic Ladder**- The 10-foot collapsible ladder is especially useful for inside work . It can easily be carried up stairways and to places where the ordinary ladder would be cumbersome. To operate, place the ladder in a vertical position and grasp each beam, pushing them apart. A baby extension ladder may also be used as an attic ladder.



Collapsible attic ladder

(g) **Rope Ladders**-Rope ladders as the word denotes is made of ropes. The strings are made of ropes and rounds/rungs are made of bamboo/wooden members. This ladder is a very versatile one and can be improvised on the spot itself. This type of ladder has the added advantage of being light in weight and easy to store. These ladders are mainly used for climbing on to an improvises bridge which is fixed at a height.

JOINING AND TESTING OF LADDERS

6. Sometimes two ladders may be joined together to form one longer ladder. To do this, one end of the ladder is placed on and overlapping one end of the other ladder. A clove hitch is given around the strings of both the ladders on one side. The loose ends are then married together and the rope taken around the strings of both the ladders and coming downwards one or two rounds and then crossing over to the other side. On the other string it proceeds in the same way but upwards and is finalised with a clove hitch parallel to the first one. The points to be noted are:-

(a) Start with a clove hitch and finish with a clove hitch.
(b) The lashing should be tight.
(c) Keep sufficient over-lapping between the two ladders.

7. **Standard Test of 35-feet Extension Ladder-** Extension ladders should be tested monthly or more often if necessary. The first test is a usual examination followed by a practical test of the strings and rungs. Examine the condition of the strings, rungs, pulleys and pawls and lubricate working parts. Look for obvious defects, especially any displacement of anchoring of reinforcing wires, cracks or shakes in the strings or rungs, loose rungs or missing wedges, riveting of cross ties and position of washers, bent or twisted pawls or pawl shaft, bent cleats, loose guides, frayed ropes, and defective fastenings of ropes to pawl shafts. Pay particular attention to the condition of the strings at the bottom of the lower half of the ladder. If the examination is satisfactory, lay the ladder flat on the ground with the strengthening wire on the strings towards the ground; extend it to the length shown by the white marking lines on the main ladder, lift it on to two trestles (or boxes, etc.) positioned about two feet from either end; measure the distance of a point in the middle of the span from ladder to ground. A man of approximately 80 kg should sit gradually on the centre of the ladder and after it has reached its limit of sag, he should spring off smartly, when the ladder should resume its previous position. If there is a discrepancy between the first and second measurements, further inspection should be made, paying particular regard to the anchoring or stretching of the reinforcement. If it appears that serious stretching has taken place in the reinforcing wire, or other defects becoming apparent during this test, the ladder should be returned to store. To test the extending rope, the ladder is erected in its closed state against a wall, two men grip a rung of both the upper and lower sections together to prevent any sliding movement whilst two men endeavour to extend the ladder by pulling on the rope. If the rope proves to be sound, the ladder is extended to its full height and two men again apply their weight to the rope. After this test, the ladder should be halved and each half raised so that the weakest parts of the rungs and sockets may be tested. Each rung should be "jumped" by a man who has ascended the ladder. The correct method is to transfer the man's weight sharply downwards from each rung to the next with the feet separated as far as the strings will permit. The height of the jump should not be increased nor used to deliver a violent blow to the rung. The ladders should be erected as nearly vertical as safety conditions permit, the head being secured and two men stationed at the foot. The ladders should then be reversed and the remaining rungs "jumped".

8. **Test of the Extending Rope**-The extending rope is to be tested by applying the weight of two men. This is carried out by pitching the ladder without extending against the wall. The weight of two men is then applied to the rope as far extending the ladder, as low as practicable, while two other men apply their weight to the extension to prevent it moving The

remaining part of the rope is tested by applying the weight of two men as earlier but with the ladder fully extended.

USING STRAIGHT LADDERS

9. ladder practices include the job of taking the ladder from its resting place, carrying it to the location where it is needed placing and raising to the climbing position securing the ladder, climbing or using the ladder, lowering, carrying to the place were kept and depositing it there. This will be covered under following sub-heads: -

(a) Securing ladder.
(b) Carrying and placing.
(c) Erecting and lowering.
(d) Climbing.

10. General- Different part of an Extension ladder and their functioning is shown below: -

(a) Close up showing top of lower half and half of upper half party extended and sliding through sides of lower half and two metal guides.

(b) Pawl in clear or sliding position.

(c) Close up of pawl in extended and locked position.

(d) View of underside of ladder, showing pawl engaged in lock position also showing reinforcing wires under the string and wrought iron ties under rungs.

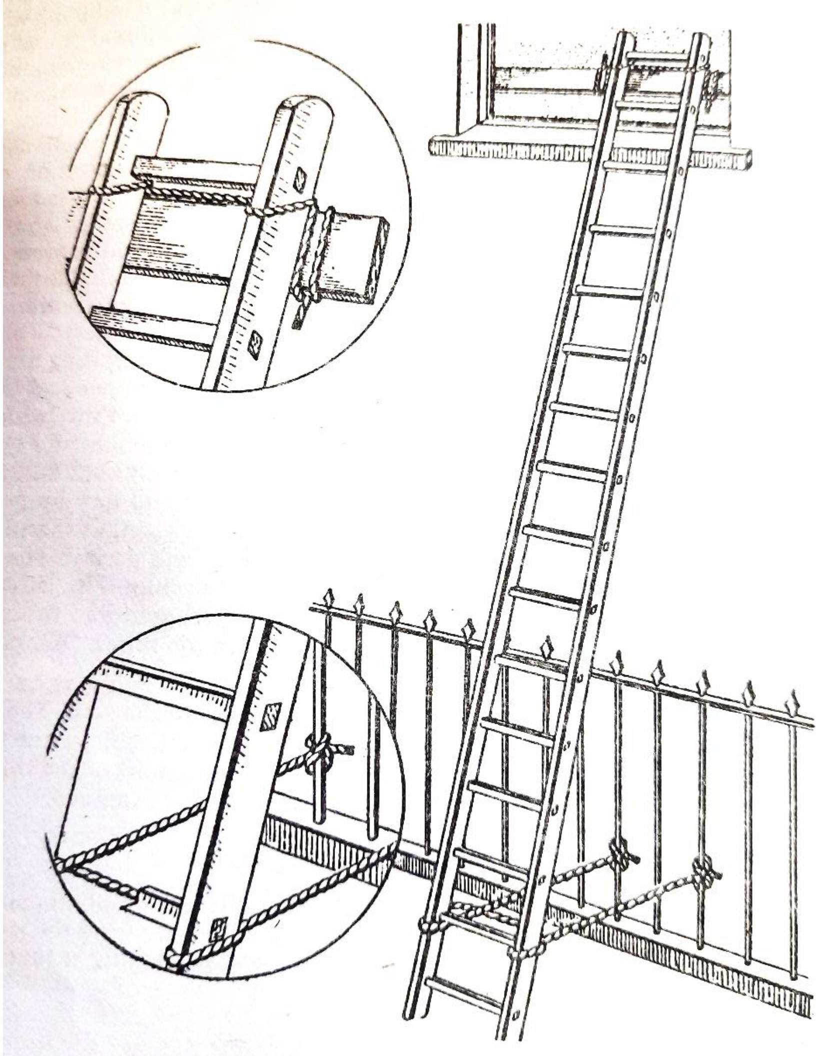
(e) Top half being raised showing pawl in clear or sliding position.

(f) Top half partly extended and pawl engaged to stop sliding.

11. **Securing**- If the ladder is to be unattended and to be made more secure and steady the heels and the head of the ladder should be secured by ropes as follows:

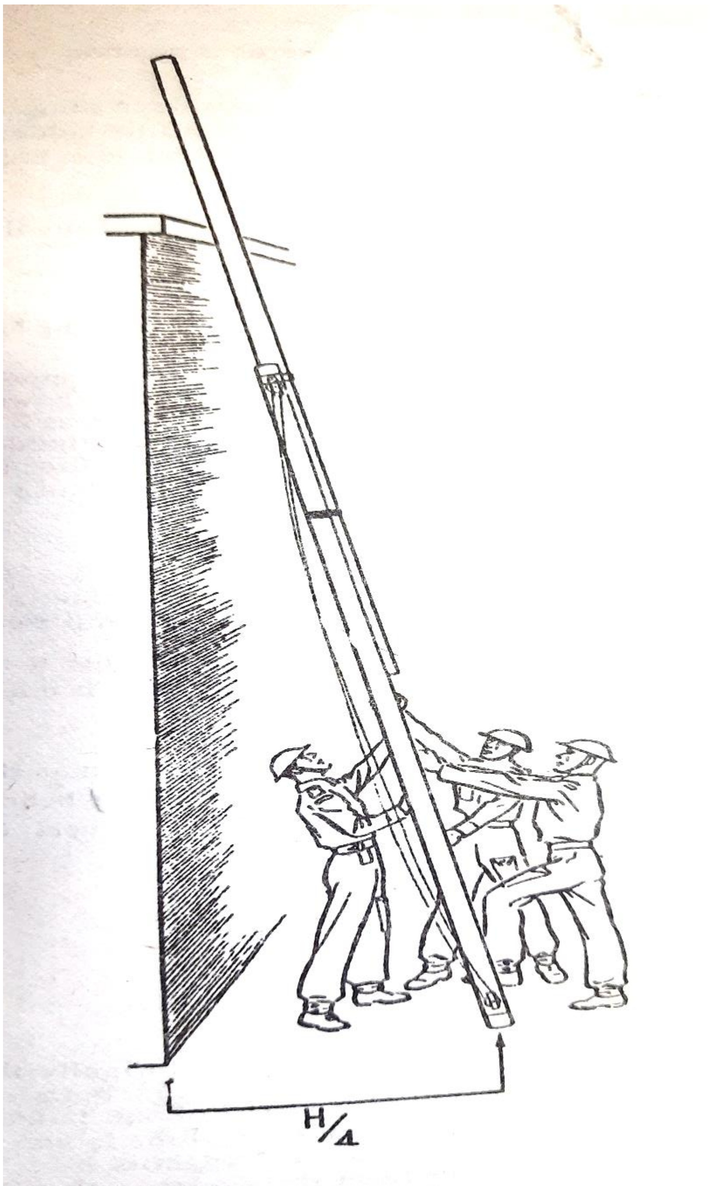
(a) **Heels**-Drive in two small iron pickets into the ground by the side of the heels of the ladder one on either side. Take a sash cord (15’ (4.54) long 1” (2.54 cms) rope) and make a clove hitch on the picket, marrying the ends of the rope and giving about six turns over the heel and the picket in the form of Figure of Eight, finishing with a clove hitch on the heel of the ladder, thus securing the heel of the ladder to the picket. Similarly, the other heel of the ladder is also to be secured.

(b) **Head**- Fasten the end of a rope to a rung on the head of the ladder by means of a clove hitch and then tie the other end of the rope to some suitable object on the higher floor by a clove hitch, thus, securing the head of the ladder.



Securing Head & Heel of Ladder

(c) **Angle of Ladders when raised**- When a ladder is raised the angle which it makes with the ground should not be too great or too acute. As a general rule the bottom of the ladder should be placed at a distance from the base of the wall about equal to one quarter of the height to be reached and the ladder should be extended so that the top of the ladder should not be less than 4 feet above the stepping-off point. This would mean that to reach a stepping-off point 28 feet above the ground, the bottom of the ladder should be 7 feet from the wall. The distance of the bottom of the ladder from the wall should never be more than half the height to be reached.



12 **Carrying and Placing**.

(a) **One-man Carry**

(i) Facing top of ladder, rescuer grasps centre of rung next below centre of ladder. Picking up ladder, he pivots extending free arm through ladder.

(ii) Ladder is carried on shoulder secured by grasping a rung with the hand that is through the ladder, leaving the other hand free. The front end of ladder should be tilted down to clear the vision of the carrier and also to prevent catching in overhead obstructions.

(iii) When at the desired location place butt of ladder against building or some other secure object.

(iv) Using both hands, raise the ladder to a vertical position by walking toward the foot of the ladder, grasping rungs.

(v) Grasp the ladder by the rungs with hands about three rungs apart, and set at a climbing angle. A good general rule is to place the butt of the ladder-away from the building distance about one-fourth of the height to which the ladder is extended.

(vi) To lower the ladder. reverse operations.

(vii) When lowered to shoulder height, it may be placed on the shoulder and carried to desired resting place.

(b) **Two-man Carry**-The practices for handling a longer straight ladder with two men are as follows:-

(i) If ladder is on the ground, men take positions facing the opposite direction to which they expect to go. They grasp & rung with palms to the front as shown and lift to shoulder height (opposite hands placed on thighs assist with lift) turning as it is raised and thrusting free arm through the ladder. With the hand that is through the ladder grasp a rung or beam for ward. If the ladder is on the truck, it may he loaded directly on the shoulders.

(ii) To carry, proceed, stepping in unison and using the free hand to guard against traffic and obstacles. Spot butt of ladder where desired.

(iii) To put ladder back on ground, reverse operations.

(iv) To raise ladder, the man on the butt places foot on heels of beam and reaches forward. grasping convenient rung. The second man takes his place alongside ladder, facing top and grasps a rung. He lifts ladder, turning under it and steps forward.

(v) If ladder has been raised at right angle to the building, it may be lowered into place against the building. If raised parallel to the building, it must be pivoted on one beam and lowered into building

(vi) A straight ladder may be raised on the beam by two men as shown below. The heel man places right foot on spur and both hands on beam. The beam man grasps centre of 4th and 5th rung raises and pivots under ladder as heel man steadies ladder and helps with raise.

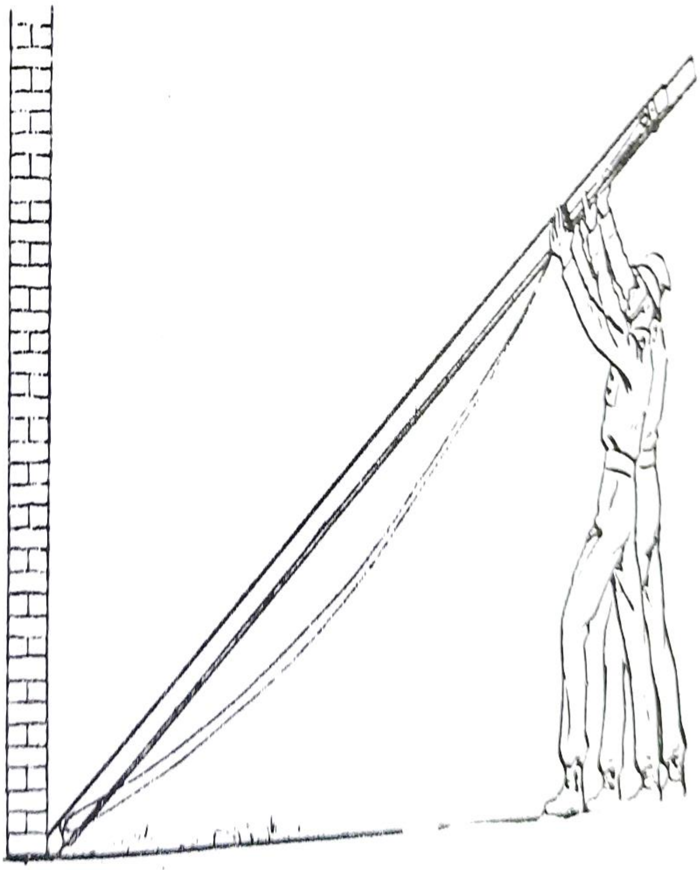
(vii) To lower ladder, reverse operations.

ERECTING AND LOWERING

13. (a) **Erecting and Extending the Ladder (three men)**-Normally three men are required to form a ladder team. No. 1 is responsible for the bottom of the ladder, both in carrying and positioning where necessary. Nos, 2 and 3 support the uppermost string of the ladder on their shoulders. On arrival at the site required for erection No. 1 places the bottom of the ladder with the reinforcing wires uppermost as near as possible for its required position and anchors it by "footing" it. Nos. 2 and 3 working on their respective sides raise the ladder from the underneath side to the vertical position. assisted by No. 1 as soon as it has reached a suitable slope to enable him to grasp the sides and exert his pull. If the reinforcing wires are not now

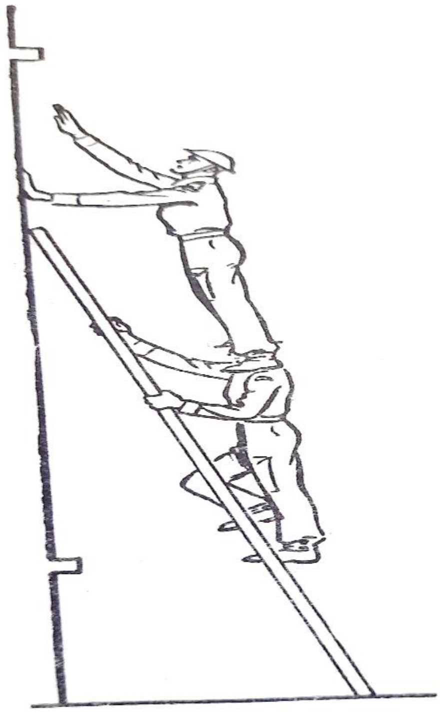
facing towards the building the ladder should be turned in the required direction, ensuring that the reinforcing wires of the ladder will be on the underside Provided that it has been correctly placed before raising, it should be unnecessary to handle or carry it far in this position. Nos. 2 and 3 face the ladder, each "footing" it, then pulling on the ropes extend the ladder to the required height ensuring that the pawl is properly engaged on the rung. The ladder is then laid back into position by No. I who walks backwards until the top of the ladder comes to rest where required-i.e. against sill. wall or floor.

(b) **Erecting and Extending the Ladder (two men)-** When no third man is available to "foot" the ladder, the bottom of a ladder should be placed against a wall, kerb or some other fixed object. The ladder is underrun in the usual manner by the(two men)- extended to the required height, and the foot of the ladder drawn outwards to the correct distance from the wall.



Ladder (two men)

(c) **Shoulder Stand-** On rare occasions when the short ladder is a little too short to reach a desired height, and the extending ladder is not available-e.g. when the short ladder can only reach to about two or three feet below a parapet or the sill of a window, it may be necessary to adopt the "shoulder stand" by which one man is enabled to reach the desired position by being mounted on the shoulders of the man underneath him on the ladder. This method should only be taught as advanced training. Two men mount the ladder, one above the other. Near the top the upper man steps back and guided by one hand of the lower man, places his insteps in turn upon the shoulders of the lower man who continues to ascend slowly with the first man on his shoulders until the upper man reaches the necessary height. After he can no longer grasp the sides of the ladder the upper man must cling to palm up the wall with his hands, leaning lightly forward to obviate falling backwards or sideways. For drill practice the "shoulder stand can be carried out by erecting confidence in the use of the top most part of the ladder and the practice should be repeated so that all men in a party have a turn at acting as "upper" and "Tower" man.



Shoulder Stand

(d) **Lowering**-For lowering ladder follow the reverse drill of extension.

14 **Climbing and Leg Lock-** Climbing ladder comes naturally to some, while others m learn through practice. The two essentials in climbing are rhythm and safety. It has been found that for most men the best rhythm is obtained by taking every rung with the feet and hands. Some prefer taking every other rung with the hands, but by so doing the ladder may start vibrating or a rang may be mined in the dark which can prove hazardous. However, climbing habits are something that will vary with the stature of each individual. The hands should be on the rungs except when carrying with one hand and then the other should be on the beam, sliding it along to prevent losing a hold Climbers should practice taking a firm, quick hold on each rung which will safeguard them in the event their feet should slip. The feet should be at the centre of the ladder to prevent wobbling The body should be kept nearly upright by keeping the arms straight. Use the ball of the foot in climbing and do not ran. Climb steadily and smoothly.

When working from a ladder, it may sometimes become necessary to keep both the hands free to ha up any sundry tool of equipment. A rescuer should not release his hold unless he had secured himself by taking a "leg-lock" The locking leg should be opposite the side where the work is to be done, and the opposite foot should be against the beam. This method leaves both hands free for handling ladders, and tools. Or a man may secure himself to a ladder with a ladder or "pompier belt" or with a rope tool placed around the waist with a hook over the rung Anchoring thus to a ladder is done when one must remain in that position for some time.

USE OF EXTENSION LADDER

15. **One Man Drill**- If an extension ladder is no longer than 35 feet, it may be carried and raised by one man. Place one foot on ground at side of beam with knee against beam to steady it. The By must be raised as follows: Grasp halyard, letting top of ladder lean toward building slightly to balance it and extend fly. When fly is raised and the halyard is secured, the ladder is lowered into the building and the bottom properly spaced. To lower ladder, place one foot on bottom rung to steady it bring to a vertical position and reverse operations. If the ladder is on a truck or on hangers, it may be loaded directly upon the shoulder of the one to carry it, in which case he will release any ladder locks holding the ladder, determine the centre of the ladder, lift it from the hooks, and proceed as described I the ladder is to be set on concrete, it may be necessary to place the heel against the building or some other object, then set it at the desired distance before raising the fly. If the ladder is to be placed in a window, it should be placed at one side and not in the centre.

16. **Two Men Drill**-If the ladder is of the length of 35 feet it can be raised by two men. With the ladder on the ground, the procedure is the same as for a straight ladder. The ladder is placed on the ground at the desired location parallel to the building. When raised, the ladder is pivoted on the beam to bring the fly ladder next to the building. When the ladder is raised directly toward the building, rather than parallel with the wall, the fly ladder should be on top before raising to bring the fly next to the building. To raise the fly in a two-man raise the inside man steadies the ladder with his hands, and the outside man raises the fly. When at the desired height, both men lower the ladder into the building. To lower the ladder, reverse the procedure. A few factors should be noted. The foot or heel man should guard the ladder with his free hand but must be careful not to have his hands or feet where they will be caught and injured by the movement of the fly ladder. The man heeling the ladder can aid materially in raising by throwing his weight back to balance the ladder. To do so he should be in a crouched position. He should watch the top of the ladder. Again, if the ladder is on the truck or on hooks, the men can load it directly on their shoulders after releasing locks, making sure they are in the correct positions for carrying Likewise, it can be loaded on the truck from shoulder position.

17. **Three Men Drill**- To raise a regular extension ladder with three men, the following procedure is recommended: -

(a) Remove ladder from truck and carry it to location, placing heel at proper distance from building before ladder is raised. (The heel man determines proper position).

(b) The ladder is laid flat, with fly on bottom.

(c) With his back to the building. No. 1 man stands on first rung, reaches forward and grasps a rung with both hands and assists in raising ladder.

(d) Facing the top of the ladder, No. 2 and No. 3 men space themselves about one-third of the distance from the top of the ladder. They reach down with their inside hands, grasp rung and raise ladder, turning their bodies under it while raising, thus facing heel of the ladder.

(e) Both men then walk toward the heel of the ladder, pushing upward on the rail hand-over hand, until ladder is in an upright position. All men should watch the top of the ladder.

(f) No. 1 on the building side and No. 2 on the outside steady the ladder while No. 3 raises the fly. No. 1 then steps back, allowing the ladder to lean slightly toward the building counteract the strain made by pulling on the fly rope.

(g) No. 1 man locks the pawls (or dogs) by pulling down on the rope from the under side.

(h) The ladder is then eased against the building by all 3 men, while each of the 2 men on the outside places his inside foot on the lowest rung to steady it.

(i) To lower the ladder, reverse procedure.

USE OF ROOF LADDERS

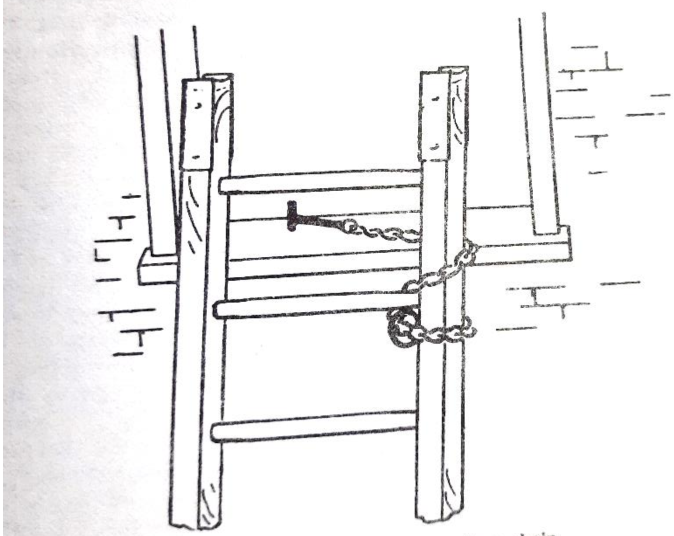
18. A roof ladder usually is carried up another ladder to be used. The evolutions consist in carrying it to and up the other ladder and placing it in position on the roof. The position for carrying a short roof ladder is the top end ahead and lower than the shoulder for safety. The man carrying the roof ladder opens the hooks before climbing. He then carries the roof ladder up the main ladder with hooks turned outward. The roof ladder is pushed up the roof with hooks downward until they are secured over the ridge pole.

If a long roof ladder requiring two men is used, both men carry the roof ladder up until the front man reaches the leave of the building, where he locks in and proceeds as before, the second man assisting . To lower the roof ladder, the operations are reversed.

ANCHORING LADDERS

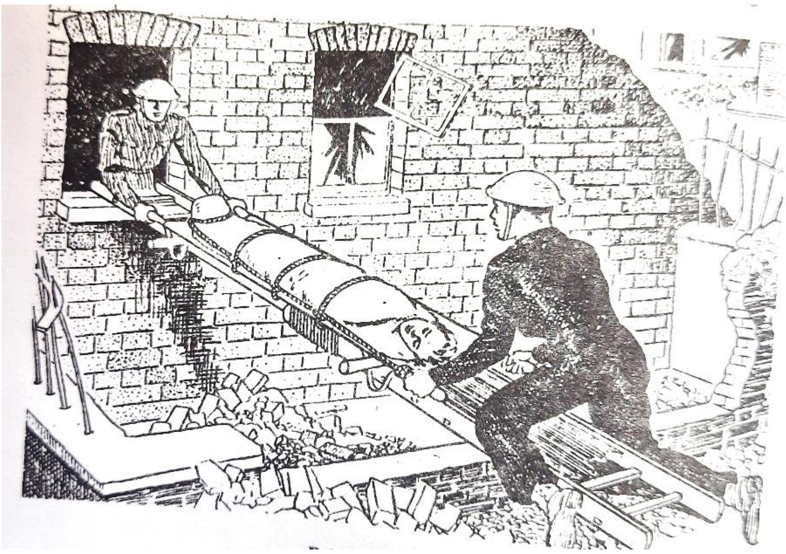
19. An important safety feature is that a ladder should be anchored to the building especially during icy or windy weather or when a hose line is to be operated from the ladder This may be done with a ladder "dog" chain, rope hose tool, hose chain, or strap as shown. Metal "dog" chains which are passed around the ladder beams and spiked with a hammer or axe into the window-sill provide the most secure method of dogging a ladder.

Dog chain



Anchoring ladder with Dog chain

20. **Bridging the Gap-** At places of incident, rescuers may sometimes have to go over from one position of a damaged building to another where there is a gap in between. In these circumstances, a ladder would prove to be very useful in bridging the gap. To do this, ladder would be placed across the two ends of the ladder resting on the two structures of the buildings over the gap, on either side with sufficient overlap, and the rescuer may then crawl or walk over this ladder thus crossing the gap in between. Boards may he placed over the rungs to improve the footing.



CARE AND MAINTENANCE

21. Ladders must be maintained in first class condition. The manufacturers have selected each part with infinite care. The wood or metal has been properly aged, seasoned or alloyed to stand up under rigorous use. In time, however, wood used in ladders may become hard and lose elasticity. Fibres may become damaged. The beams may splinter and rungs become loose if periodic attention to maintenance is not given. Weakening of a ladder from any of these causes or from overloading may cause ladder failure. The loosening of rungs or blocks presents additional hazard, and usually results from neglect. Constructional joints of the wooden ladder should be kept water resistant. Ladder should be varnished but never painted so as not to conceal defects. The greatest stress on ladders usually results from overloading them. Ladders are commonly overloaded when placed at an improper angle.

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CHAPTER 11

USE OF IMPROVISED AND MECHANICAL EQUIPMENT IN RESCUE

1. **Introduction-** During the rescue work a number of situations may be confronted by the rescue teams wherein it may be required to lift or lower large loads/casualties with minimum available man power. Thus, to offset the disadvantage of lack of human resource the use of Blocks and Tackles, Levers and Jacks and field machines are used to achieve mechanical advantages.

2 All rescue teams must be proficient in the handling of undermentioned equipment for obtaining mechanical advantage during rescue work.

(a) Blocks and Tackles.
(b) Levers and Jacks
(c) Hauling and lifting equipment.
(d) Pickets and Holdfasts
(e) Field machines
(f) Heavy duty mechanical equipment

BLOCKS AND TACKLES

3. Blocks and tackles are used as lifting devices for raising or moving heavy weights, beams, sections of floors and heavy timbers during rescue work. The main purpose in using these gadgets is to gain mechanical advantage thereby enabling rescue workers to overcome otherwise immovable obstructions. They are also used for changing the direction of ropes. Depending upon the job required to be done a single, double and triple sheaved blocks as well as snatch blocks may be used.

4. **Terminology**- A block is composed of a frame made either of wood or metal and a wheel or sheaves usually made of steel. Some of the terminologies connected with standard block and tackle are explained below:

(a) **Block** -A grooved pulley or sheave in a frame or shell provided with a hook or strap by which it may be attached to another object.

(b) **Tackle**-An assemblage of ropes and pulleys arranged for hoisting or pulling.

(c) **Pulley or sheave**-A grooved wheel held in the frame over which ropes must pass.

(d) **Snatch block**-A single block with an opening or gate on one side through which a rope can be inserted or "snatched" into the sheave without threading the end through.

(e) **Frame or shell**-The part of the block which holds the sheave, and to which the strap, hook, or ring is attached.

(f) **Strap**-The part to which a hook is attached.

(g) **Standing block-**The block fastened to the support from which the load is being moved, when more than one block is necessary.

(h) **Running block-**The block attached to the object to be moved when more than one the block is necessary

(i) **Overhauling the blocks-**Process of separating two blocks a desired distance (at least distance the load is to be moved) before attaching the running block to the load.

(j) **Running in the blocks-** The process of bringing the blocks closer together in a lifting or moving operation.

(k) **Chock-a-block-** When two blocks have been run in as far as they can possibly go.

(l) **Becket, or ring-** Metal ring fastened to block for attaching rope or chain.

(m) **Standing end of tackle-** End of rope fixed to the block at the becket.

(n) **Running end of tackle-** End of rope on which the pull is exerted.

(o) **Reeving the tackle-**Process of passing rope over sheaves of a block in proper order.

(p) **Twisting of the tackle-** A motion of the tackle during pulling usually caused by a peculiar lay in the rope.

(q) **Returns-**Moving sections of rope between blocks.

(r) **Power gain, or mechanical advantage-** Increase in lifting or moving capacity gained by using the block and tackle.

(s) **Heave-**Signal for members of the team to exert pull on rope: also the act of pulling.

(t) **Gain-**Distance the weight is lifted or moved.

5. **Blocks-**Blocks are used for the purpose of changing the direction of the ropes and when made up into a tackle of gaining power. The essential parts of a block as used in rescue work are generally made of malleable cast iron or steel. These are:

(a) **Shell-**The case containing the sheave

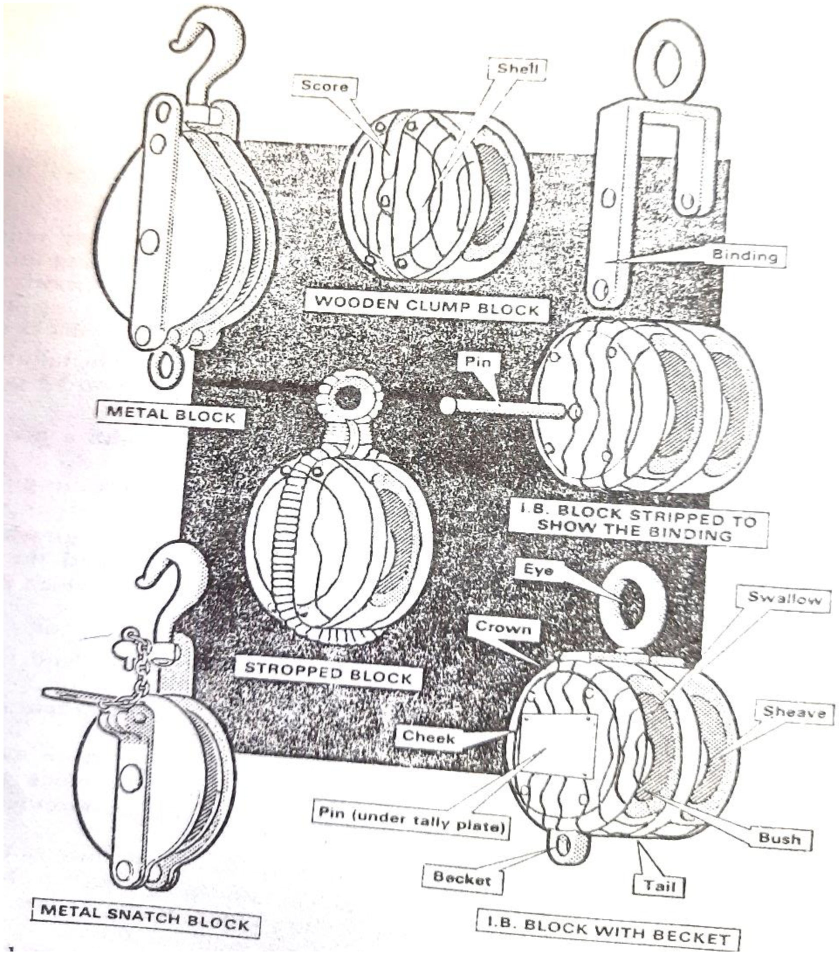
(b) **Sheave or pulley-**The wheel upon which the line travels.

(c) **Bush-**The metal centre of sheave often with metal roller.

(d) **Pin-**The shaft upon which the sheave revolves.

(e) **Becket-**To which rope is fixed above the block.

(f) **Hook-**The hook of a block is always secured to the crown.



6. Ropes to be used for blocks depend upon the diameter of the sheave. If the sheave is too small the strength of the rope especially wire rope is seriously damaged and a proportion of power is lost. On the other hand, the smaller the sheave the lighter the for wire the diameter of the sheaves should be at least six times the circumference of the rope.

7. Blocks are called as single, double or triple according to the number of sheaves in the frame. As a rule either the safe load or test load should be stamped on the block.

8. Snatch block are single blocks with an opening in one side of the shell in order that a rope can be inserted without passing the end through it. This opening is closed by a hinge strap.

9. **Tackles**-Tackles are composed of one or more blocks, rove with a rope or fall. They are described as single, double, triple tackles and are denoted 2/1 or 3/2. The following terms are used in this connection

(a) **Fall**-The term used for the rope connecting the blocks.

(b) **Reeving**-The operating of passing the fall round the sheaves of the blocks.

(c) **The Standing End**-The end of the fall made fast to one of the blocks at the becket.

(d) **The Running End**-The loose end of the fall to which the power is applied.

(e) **The Returns**-The parts of the fall between the blocks.

(f) **To Overhaul a Tackle**-To separate the blocks, with heavy tackles, the block from which the running end comes off should be secured to a holdfast, and a hand-spike should be placed in the hook of the other block with a drag-rope, should be manned, while one or two men overhaul the returns from the standing block. The hand-spike is intended to keep the tackle out of the dirt which would otherwise clog the sheaves

(g) **Choc-a-bloc**-When the blocks are as close as they will go, they are said to be choc-a-block.

(h) **To Rack a Tackle**-Any two opposite returns should be fastened together with a seizing so that the blocks will retain their relative position even if the running end is let go.

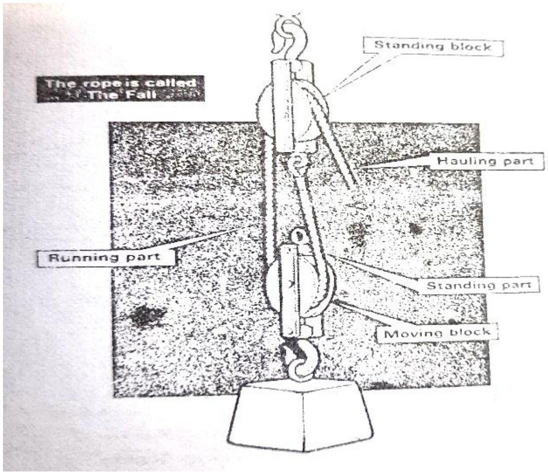
(i) A lifting tackle is one in which the running end of the fall comes off the fixed block, it is normally used vertically.

(j) A runner tackle is one in which the running end of the fall comes off the moveable block, it is normally used horizontally.

(k) A leading block is used to change the direction of the running end in order that the power may be favourably applied. As a rule, leading blocks are required for lifting tackles and not for runner tackles. They should be made so fast as to give a good lead to the fall which runs through it. Snatch blocks are normally used.

(l) The power is supplied to the running end by a winch or a caps tain or by men pulling directly on the fall. Men cannot grip wire rope sufficiently well to apply power equal to the strength of the rope.

10. **Parts of a Tackle**- The blocks of a tackle are known as the 'standing block' and the 'moving block. The rope which is rove through the blocks is called the fall. and has its standing and hauling parts.



parts of a Tackle

11 **Reeving Tackle**- To "reeve" a tackle, two men should stand back to back about 6 feet apart with the blocks slightly in front of them between their feet and the hooks pointing

outward. The coil of rope should be to the left of the top block for 3/2 tackle. The first man should reave the standing end of the rope through the lowest sheave of the top block, then pass it to the second man who will reeve it through the lowest sheave of the second block The rope should be passed successively through the sheaves of both blocks from left to right and finally made fast to the becket of the second block by two half-hitches. The running end should he secured to prevent it from slipping

12. **Types of Tackle**- When referring to a particular tackle the following are used.

(a) **3 and a 2 tackle**- A three-sheave block and a two-sheave block.

(b) **2 and a 2 tackle**-A two-sheave block with a two-sheave block.

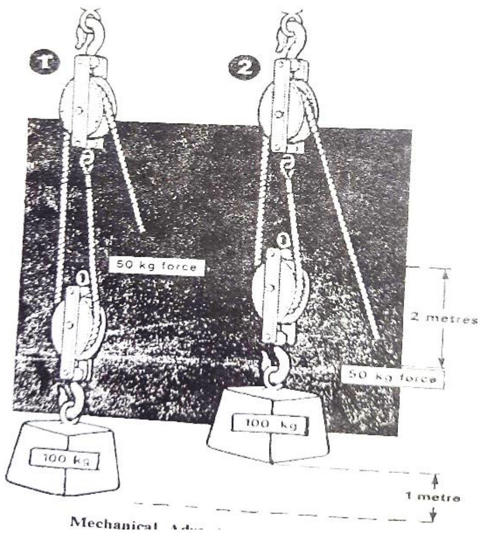
13. "Jinny wheel", or a single-sheave wheel, commonly used by builders for hauling up or lowering material, is not used in rescue but a similar rig can be made using the snatch block. The tackle most commonly used in rescue is the 3 and a 2, using the three-sheave block and two-sheave block provided in each set of equipment. The snatch block is used with derricks, sheers and gyns to allow change of direction of the rope and facilitate hauling. Using the 200-foot 3-inch fibre rope and the 3 and a 2 tackle, the following maximum loads can be dealt with:-

(a) Lifting .. .. .. 1500 Kg.

(b) Hauling .. .. .. 1800 Kg.

The maximum distance a weight can be moved with this tackle is 26 feet

14. **Mechanical advantage**- The amount by which the pull in the hauling is multiplied by the tackle is known as the 'mechanical advantage (MA) and, disregarding friction, that is equal to the number of parts of the fall at the moving block. In the figure below, there are two parts at the moving block and therefore the mechanical advantage is 2: in other words, it only requires a force of 50 kg. on the hauling part to raise a weight of 100 kg.

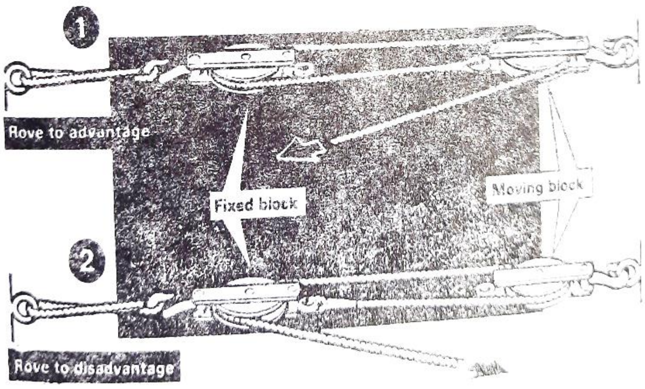


Mechanical Advantage & Velocity Raito

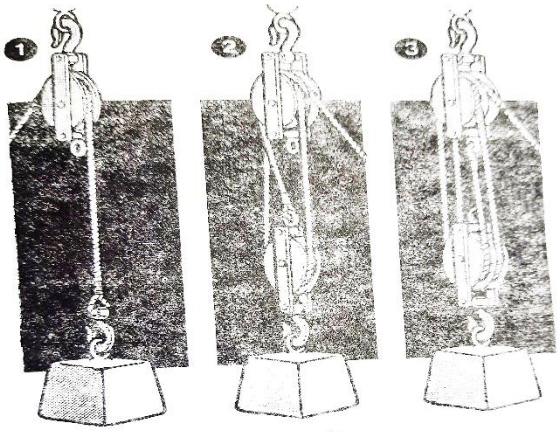
Mechanical advantage, however, is only gained at the expense of working, and it will be seen in figure, that for any two metres of movement of the hauling part, the weight will only be raised one metre. The ratio between the distance moved by the hauling part and that moved by the moving block is known as the velocity ratio, and is always equal to the number of parts of the fall at the moving block.

When a tackle is being used, however, considerable friction is set up, both in the bearings of the blocks and within the fall as it bends round the sheaves. This friction accounts for the difference between the mechanical advantage and the velocity ratio of the tackle. For example, in a tackle where the velocity ratio is 3, the mechanical advantage may only be about 2:3.

15. The number of parts at the moving block, and therefore the mechanical advantage, is always greater when the hauling part comes away from the moving block, and a tackle in such circumstances is said to be rove to advantage whereas when the hauling part comes away from the standing block, the tackle is said to be rove to disadvantage.



16. **Use of tackle**-The simplest method of raising a weight by means of a block and tackle is to reeve the line through a single block, attach one end of the line to the weight, and haul on the other. This is the single whip where there is no mechanical advantage and the velocity ratio is 1: 1. When the weight is too heavy to be lifted by this means, the introduction of additional blocks will increase the mechanical advantage. In figure below are shown examples of a luff tackle, where the mechanical advantage is three times, and a two-fold purchase double luff tackle, where the mechanical or advantage is four times, in both cases disregarding friction.



Use of Tackle

It will be seen that the manner in which a tackle is rove is of practical importance, and if an alternative is possible, the position of maximum advantage should always be employed. The manner in which a tackle is rove is, however, conditioned by the lead of the hauling part of the fall Le by whether the object to be moved is being drawn towards the person hauling in which case the t leads from the moving block, or away from him, in which case it leads from the standing block although this position is rove to disadvantage.

17. The following practical points in the use of tackles should always be observed :-

(a) When calculating the type of tackle, provide plenty of spare power to allow for easy working.

(b) Remember to allow for the space taken up by a tackle when choc-a-bloc, and the space required for the hauling team.

(c) The final pull should be horizontal if more than two men are to pull.

(d) Men should be trained to pull together and hold what they get. Sometimes, where a smooth poll is required, instead of heaving it may be desirable for the hauling party to walk away with the fall after the first heave. The fall should be double banked in order to keep the pull in a straight line.

TACKLE CALCULATIONS

18. **Lifting Tackle**- A lifting tackle has the weight attached to a moving block (the lower block) and the running end of the fall coming off the fixed block (or upper block). When calculating the strength of a lifting tackle, it must first be realised that only the returns between the blocks are assisting to lift the weight and that the running end is not helping in the lifting. The power is exerted directly on it and in the opposite direction, to that in which the weight is moving. The factors to be taken into consideration in calculating the strength of a lifting tackle are:

(a) The unit strength of the fall (circumference x circumference in CWTS) C in mm x 0789-Kg)

(b) The number of returns at the moving block (including the standing part if it is made fast to the moving block).

(c) The loss of efficiency of the tackle owing to friction one third reduction is allowed. For example, using a 3/2 tackle. Reeved with a 3" (76.2 mm) fibre rope, the strength will be calculated as below:

(Unit strength of rope) x (Returns at moving block) x 2/3 (friction loss) which is (circumference X circumference) X (returns at the moving blocks).
(3x3) x 5-45 x 2/3- 30 CWTs (or in e.g. system, (76.2 x 762 x .0789) x 5 x2/3 1526.66 kgs).

19. **Hauling Tackle**-A hauling tackle is one in which the running end of the fall comes off the moving block to which the weight being hauled is attached. The fixed block is made fast to a hold fast or otherwise anchored. While calculating the strength of hauling tackle it must be remembered that the running end of the fall is pulled in the same direction as the weight to be moved and assists the returns to move the weight. The running end must, therefore, be

included in the calculation assessing the number of returns at the moveable block. For example, using a 3/2 tackle reeved by a 3-inch fibre rope, the strength will be as follows:

(Unit strength of rope) x (returns at moving block plus running end) x 2/3 (friction loss) (circumference x circumference) x (5+ 1) x 2/3-54 x 2/3-36 CWTs (or in C.G.S. system where Circumference is in mm. (76.2 x 762 x .0789 x (5+ 1) x 2/3 2/3-1832 Kgs) 458 x 6 X2/3-1832 Kgs.

20. **Length of rope required for a Tackle-** The longest length of rope carried on a rescue vehicle is 200 feet. It is, therefore, necessary to know the maximum length of a tackle that can be reeved with this rope and also as to how to calculate the length of rope required for a tackle that will move weight through any given distances. The following are taken into consideration for calculating the same:

(a) The number of returns between the blocks plus the running end. (This is quickly assessed by counting the total number of sheaves in the blocks and adding one for the rope required as a running end.)

(b) The distance that the weight has to be moved either vertically or horizontally.

(c) The overall length of a tackle when choc-a-bloc (normally a constant of 4 ft (1.20 M) when measured from hook to hook).

(for example if a weight is to be moved a distance of 26 ft. (7.80 M) by means of a 1/2 tackle, the length of the rope required will be as follows)

(Number of sheaves + 1) x (Distance to be moved + choo-a-bloc).

(5+ 1) x (26+4) 6 x 30= 180 ft. length of rope (or in C.G.S. system), (5+ 1) x (7.80 x 1.20)-6x9-54 M.

21. **Anti-Twisters**

(a) All tackles are liable to twist when the power is applied due to the lay of the rope and not to the method of reeving the tackle. Although many methods reeving has been tried to prevent the twist, none are satisfactory, and it is necessary to fit some form of arti-twister to the tackle. Long tackles and new ropes are more liable to twist than short ones and old ropes new ropes should be well strengthened and as much twist as possible taken out of them by making one end fast to a swivel and pulling on the other

(b) The most suitable type of anti-twister at a moving block in a horizontal or sloping tackle. consists of a maul with the helve passed through the loop of the first half hitch of the standing end on the becket and projecting at least 6 inches above the returns of the tackle. (figure). To fix it, make a split clove hitch round the head of the maul, pass the double end of the spun yarn up the heave and secure it to the helve with two half hitches take a round turn through the becket, and one turn of a square lashing with the double spun yarn round the helve and the loop of the standing end. Finish off with frapping turns made with each part of the spun yarn in opposite directions and tie a reef knot.

(c) The tackle is prevented from twisting by the suspended weight of the maul. In long tackles, or is the head of the maul is too light, an additional weight must be secured to the bottom of the maul or a crow bar may be used instead, the crow-bar should be secured in a similar way except that no split clove hitch can be used.

(d) A vertical tackle cannot be prevented from twisting by the maul anti-twister. In this case, a light bar such as a picket or hand spike, should be placed through the loop of the standing end and fixed to the becket. The tackle is prevented from twisting by men holding the reins attached to each end of the bar.

22 **Care of Tackles**- If tackles are to work efficiently, and produce the estimated power gain, all friction losses must be reduced to a minimum by observing the following points:

(a) Block must be well lubricated and free from grit and dust. If blocks complain, i.e. make a noise, they are not in a good working order.

(b) The fall must be free from kinks and twists, and must run freely over the sheaves.

(c) Tackles should be carried and not dragged along the ground (for method see chart).

(d) Tackles must be prevented from twisting. The power required is increased by over 40 per cent if a tackle is allowed to twist one complete turn

(e) The correct size of block for the rope must be used.

23. **Safety Precautions**-The following safety precautions should be taken while using blocks and tackles in rescue work:

(a) Ensure that the rope selected is suitable to lift the weight required.

(b) Be sure that you have enough length of right type of rope to be used.

(c) Check that the right size of the rope is used for the blocks.

(d) Ensure that the blocks are greased properly and always kept free from grit.

(e) When pulling a load ensure that all the men exert a steady pull on the fall and that they do not jerk. The leader should give the orders, and all the members should pull simultaneously and hold on to the gain. The men should stand alternatively and keep the rope in a straight line.

(f) When fixing a lifting tackle to a spar or a hauling tackle to a post ensure that the spar or post can take the strain of the weight of the object, weight of the tackle and the pull exerted on it.

(g) The members should be pulling away from the lifting tackle, so they will not be hurt in case the support fails.

(h) When pulling on a fall, ensure that all the men pull in a direct line with the sheaves of the block. If possible, the pull should be downhill.

(i) When paying out the fall it should be smooth, easy and without jerks. A turn should be taken with running end around the picket or hold-fast, to prevent the weight on the tackle acquiring the charge due to momentum. Likewise, precaution is necessary when taking in a tackle. One man should be made responsible for taking in spare end and to keep a round turn on the picket. A suspended weight should be eased off uniformly and not with jerks.

(j) When the fall is taut it should not be struck or trodden by men.

(k) While the tackle is being used the return near the sheaves of the blocks should not be touched. The fingers of the men may get caught between the returns and the sheaves. When absolutely necessary, the return away from the blocks can be eased.

(l) After lifting a weight, do not leave the tackle with the strain on, release the strain by lowering the tackle an inch or two, so that the stress is distributed equitably among all the returns.

(m) Never use wire rope in a block meant for fibre rope or vice versa.

JACKS AND LEVERS

24. **Introduction**-The rescue party members while extricating casualties from under the debris are likely to be confronted with very heavy loads. These may be steel girders, cement concrete slabs or blocks of brick work. An average person should not normally attempt to lift more than 80 per cent of his own body weight. Thus, it will be seen that very heavy weights cannot be lifted unless some mechanical devices are made use of. Besides, the weights to be lifted may be so bulky and difficult to grasp that they are not capable of being dealt with by manual lifting alone, and at times portions of the building may be required to be held fast to prevent it from collapsing. Hence to provide rests for such heavy loads the use of mechanical devices is inevitable.

25. **Levers**-The simplest appliance for gaining power is lever, of which an improvised version made of laminated timber or an ordinary crow bar are most frequently used by rescue workers. Basically, it is a device used for lifting during rescue work and gains power by a sacrificing distance.

(a) **Description of lever**-A lever consists of two parts i.e., a long rod or spar called the lever rod is the first part and second part is called the fulcrum. Any solid piece is used as fulcrum. This mechanical device is usefully employed when the object is too heavy for man handling or too bulky or difficult to grasp. Mechanical advantage of a machine can be calculated by the formula:

Mechanical Advantage (M.A.) $\frac{W}{E}$ where

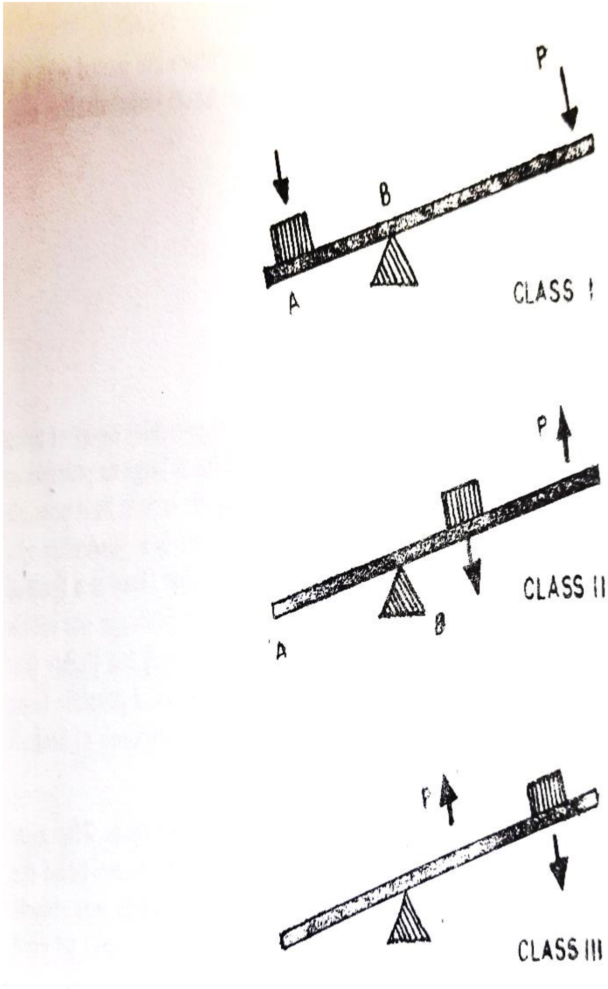
W is the weight and E is the effort.

(b) **Classification of Levers**-The levers are of 3 classes:-

(i) **Class I Lever**-The load and the applied force act in the same direction but from the opposite sides of the fulcrum. Example: pickaxe.

(ii) **Class II Leve-** The load and the force act in opposite directions but from the same side of the fulcrum, the effort arm is longer than the resistance arm. Example: Nut cracker.

(iii) **Class III Lever-** The load and the applied force act in opposite directions from the same side of the fulcrum, but the effort arm is shorter than the resistance arm.



(c) **Use of levers**-Levers are useful for lifting, moving or preventing the movement of objects. There are two distinct ways of using the levers. Ohe by exerting force upwards and second exerting downwards. In both the ways, the advantage gained depends on the ratio of force from fulcrum and the distance of object from fulcrum. The advantage increases or decreases as the fulcrum is moved nearer or away from the object. The force required at a distance from the fulcrum can be calculated with the help of the formula given below:

$$\frac{\text{Load}}{\text{Applied Force}} \qquad \frac{\text{Lever arm of the force}}{\text{Lever arm of the load}}$$

How much force will be required to be applied at a distance BC 9' (2.70 M) from the fulcrum to lift a weight of 720 lbs. (326.59 kgs.) placed at a distance AB 1' (30 M) from the fulcrum when the lever 12 (3.04 M) long.

Solution

Suppose, the force required to be applied is X lbs. Then applying the formula,

$$X = \frac{720\ (326.59)}{6\ (2.70)} \text{ X } 2(.30\text{ M}) = 80 \text{ lbs. } (36.28 \text{ Kgs.})$$

(d) **Method of using levers**-Always the force applied to the lever should be as near to the end of lever as possible. Objects should be packed up as they are lifted to take the weight of the lever rod. This will also enable to obtain an additional mechanical hold to raise the object higher. The packing material should be uncrushable and the packing should be seen throughout the entire surface of the lift. In case more than one lever is used, the levers should be used in such a way that the object does not tilt on lifting and force applied should be even. The lifting should be well co-ordinated and controlled by the leader.

(e) **Objects that can be used as levers**-As far as possible the rescue parties should improvise the

levers on the spot at the place of damage. Sometimes the rescue parties are issued with a 10 feet iron shod lever in their equipment. However, the stress should be on improvisation some of which are mentioned below:

(i) Pinch point crowbar.
(ii) Claw and wrecking bar.
(iii) Pick.
(iv) Any substantial section of lumber.

26. **Fulcrum Blocks**-A fulcrum block should be of wood (hardwood if possible) never of brick or other crushable material. It must be resting on a firm base, which should be as large as possible so as to distribute the weight to be lifted. The fulcrum must be placed as near to the weight as is possible under the circumstances and it should never be placed at any point where there is a possibility of a casualty being buried immediately below. It should, however, be remembered that there is a limit of strength to all levers, and if either the weight to be lifted or the applied force or both are not within this limit there is a distinct possibility of the lever collapsing. It cannot be stressed too highly that such a collapse of equipment whilst attempting to effect a rescue is not only the worst possible thing that could happen so far as the casualty is concerned, but is also a clear demonstration of lack of leadership, team work, and training.

27 **Jacks**-The jacks that are issued to the Rescue Parties are mainly of two types. The mom important and common type of jack is the screw jack. This type as the name indicates works on the principle of a screw which is rotated to raise loads with the help of a lever. This type is very simple and compact and in this the chance of slip back is almost absent. Four main types as could be used in rescue work are described in details below:

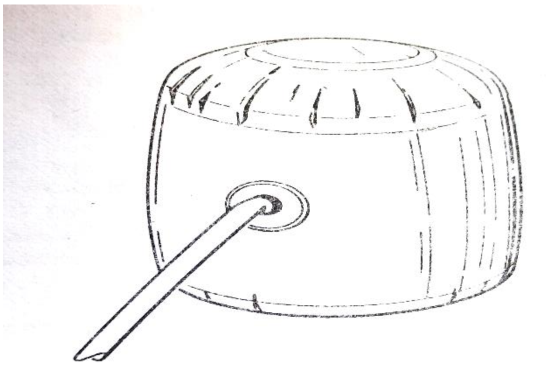
(a) **Ratchet Jacks**-With this type of jack the load is raised by means of a long lever working against a ratchet. This jack, though simple in action, has the disadvantage that because of the ratchet it is somewhat tall in construction and consequently cannot be used where the space is restricted. Ratchet jacks are fined with a toe so as to get a lift from very near the ground. This toe, however is generally capable of carrying only ratchet, thus allowing the weight to come on to the lever. To avoid accidents, the jack is so constructed that the ratchet cannot be released until the weight is taken by the lever.

(b) **Screw Jacks**- As the name implies, this type of jacks works on the screw principle. A lever is used to rotate the screw which in turn raises or lowers the load. The screw jack is very compact and safe in operation as it almost eliminates any risk, or slip back which in rescue work might cause serious accidents.

(c**) Hydraulic Jacks-**These jacks are constructed on the principle of the hydraulic ram. The body consists of the cylinder into which the ram or piston is fitted. By means of a hand pump operated by a lever, oil is forced into bottom of the cylinder and exerts a pressure on the underside of the piston which in turn raises the load. To prevent the oil from flowing back a non-return valve is fitted between the pump and the cylinder. To lower the jack a controllable valve is fitted between the cylinder and the oil reservoir in the body of the jack to permit the oil to flow back into the reservoir again, thereby releasing the load at a speed controlled by the control valve. The hydraulic jack is not so simple in construction as the other two types. It is however, very compact and can be constructed to have almost any degree of power without undue mechanical difficulties.

(d) **Pneumatic Jacks-**These jacks are operated on the principle of air pressure. The pressure is developed by connecting the equipment to exhaust of a vehicle or by means of pumps. However, the usefulness of this equipment is limited to vehicle crash.

(e**) Air hags**- Air lift bags, which can quickly be inflated with compressed air from a compressor or vehicle engine/exhaust, can be usefully employed for all types of lifting operations. These bags have got different sizes and different lift capacities ranging to several tons. The top and bottom portion of the air bags are made of nylon fabric 9.4 mm. in thickness to avoid cuts, tear and puncture. Air lift bags require 37.5 mm. of clearance for placement a maximum 6 psi air pressure is needed for its inflation. They are ideally suited for lifting vehicles or operation in soft/small bearing surfaces like slush. It can also be used for shoring.



Air lift bags that can be quickly inflated are extremely useful in all types of lifting and spreading operations.

As they have a large bearing surface, they will readily conform to soft and uneven surface.

28. **Use of Jacks-** For the effective and safe use of jacks, the following points must always be observed:

(a) The jacks should stand on timber or other footing of sufficient size to distribute the load, otherwise instead of lifting the load, the jacks will be forced into the ground.

(b) As the weight is lifted, solid material supports should be placed under it to prevent damage if the jacks should fail. The weight of raised sections of walls and floors should not be allowed to rest entirely on the jack while rescue workers crawl under Cribs should be set under heavy weights or sections of floors to prevent setting after lifting operations is completed. Cribbing can be done with timbers of various sizes ranging from 2 to 8 feet in length, depending on the weight to be supported and the available working space. Be sure that the ground is level at the point where the crib is to be set. (It is better to level off high spots than to fill low ones). The cross-tie crib (as in attached chart) will be infrequent use, since it is a safe method of supporting heavy weights. Space several timbers well apart and parallel, then put another level of timber on top of and at right angles to the ones on the first level. Each added level is at right angles to the one below it. The number of layers needed will depend on how high the load is to be lifted (pack as you jack).

(c) Suitable packing, such as sound or hard timber and folding wedges, should always be used between the head of the jacks and the surface of any load liable to slip, such as when a metal contact occurs.

(d) Every effort should be made to operate the jacks in a plumb position, but if this is not possible, suitable packing should be used to obviate slipping or skidding when the load is applied.

(e) Ratchet and other yall jacks are fitted with a toe so as to get a lift from very near the ground. This toe, however, is generally capable of carrying only one-third of the total jack load

(f) Where two or more jacks are used simultaneously to raise the same load, they must be operated evenly to avoid tilting the load and also to avoid bringing too much weight on to one jack with consequent risk of failure.

(g) All jacks must be kept perfectly clean, well-oiled and greased. They should be examined and tested under load at frequent intervals.

(h) Work from a good foundation.

(i) Use wedge as a safety chock.

(j) Never leave a jack under load-lest it may slip and cause a serious accident.

(k) Raise or lower jacks evenly whenever there are more than one jack employed in raising the object.

(l) Always remove the jack handle when it is not in use.

(m) While lifting objects of metal use timber packing between the head/toe of the jack or the tip of the iron shod lever.

(n) Ensure that the 'UP' and 'DOWN' latches of the jacks are in working condition. (In the case of ratchet jacks)

29 **Approximation of loads**-During rescue work there may be a requirement to assess the rough weight of some objects so that a decision could be taken by the rescue leader with regard to the equipment that could be applied for its lift or support. The ready reckoner is given below:-

(a) **Brick work/Concrete masonry**

(i) 9 in 1226 cms brickwork, per square foot	84 lbs (37.80 kg)
(ii) 13 ½ in (34.29 cms) brick-wick per square foot	126 The (56.90 kgs)
(iii) Concrete and masonry, per cubic foot 103 cm)	120/160 lbs (54.72 kgs.)
(iv) Bear partitions 3ft. x3 ft. x3 in 1(90 cm x 90 cm x 70.50 cm)	152 lbs (68.40 kgs)
(v) Breeze partitions 3. x3. x4 in (90 cm x 90 cm. x 10.10 cm)	216 lbs (97.20 kgs)
(v) Floors 2 in x 4 in 1505 cm. x 10.16 mi timber joists and flooring per square f 10 The	6/10 lbs (97.20 kgs)
(vi) Floor 2in x 7 in. (05 cm. x 1752 cm) or 2 in. x 9 in. (5.88 x 22.57 cm.) timber joists and flouring per square ft.	10/18 lbs (4.50/3.10 ks)

(b) Steel Sections/Channels.-Approximate weights of 10 ft. lengths of steel sections, joists and channels with average thickness web and flanges are:-

(i) 10 in. x 6 in (254 cm x 15.00 cm) Rollest steel joints	400 The (180 kex)
(ii) 9 in x 4 in (22.57 cm x 10.16 cm) Rolled steel joists	210 lbs (94.50 kgs)
(iii) 7 in x 3 in. (1752 cm x 750 cm) Rolled Steel Joists	150 lbs (67.50 kgs)
(iv) 6 in. x 8in. (15.24 cm x 2030 cm) Rolled Steel Channel	125 lbs (56.25 kgs)
(v) 7 in. x in. (17.52 cm x 2032 cm) Rolled Steel Channel	140 lbs (63 kgs)
(vi) 8in. x 8 in. (20.32 cm x 20.32 cm) Rolled Steel Channel	160 lbs (72 kgs)
(vii) 2 in x 4 in. ¼ in. (5.08 cm x 5.89 cm x 64 cm) Steel angle	30 the (13.00 kgs)
(viii) 8 in x 3 in. x $^{3}/_{8}$ in. (20.38 cm x 7.50 cm x 0.94 cm) Steel angle	70 lbs. (31.50 kgs)
(x) Steel roof trusses 20 f. (610 m) span (average)	250 The (112.50 kgs)
(xi) Steel roof trusses 20 ft (18.00 m) span (average)	600 lbs (270 kgs)
(xii) Steel roof trusses 20 f. (18.00 m.) span (average)	1200 lbs (540 kg)
(xiii) Timber trusses 20 ft. (6.10 m) span (average)	2400 lbs (1000 kgs)
(xiv) Timber trusses 30 ft (9.00 m) span (average)	350 lbs. (157 kgs)
(xv) Timber trusses, 40 ft (12.00 m) span (average)	800 lbs. (360 kgs)
(xvi) Timber trusses, 60 ft. (18.00 m.) span (average)	1500 lbs. (675 kgs)

HAULING AND LIFTING EQUIPMENT

30. **Introduction**- Until very recently the equipment available to the rescue services for raising/ lowering weights, or for hauling loads was the long 3/2" fibre ropes or various pulley blocks used in conjunction with derrick poles sheer legs and the pull lift. With the type of area damage that is likely to result under non-conventional strike in a populated region, such heavy equipment may be difficult to be carried to scene of rescue operations by the rescue parties. It therefore becomes important to familiarise the rescue team with a suitable and convenient type of equipment which could be carried by the team to the site of requirement. The pulling and lifting machine known as TIRFOR' is now locally available and fulfils all requirements of rescue work.

31. **Tirfor**

(a) **General**-The appliance consists of a machine or casing through which passes a steel cable which is attached to the load to be hauled or lifted. The operation of a lever handle backwards and forwards pulls the cable through the machine which in turn if properly anchored hauls the load towards itself .

(b) **Description of equipment**-The equipment consists of:-

(i) A pulling and lifting unit complete with a swivel hook to enable it to be secured.

(ii) A detachable tubular steel handle for operating the unit.

(iii) A length of flexible steel wire rope 60 feet long. 7/16 in. diameter, fitted with a hook at one end, the other end being tapered and fused. This rope is coiled on to a reeler for convenience in carriage.

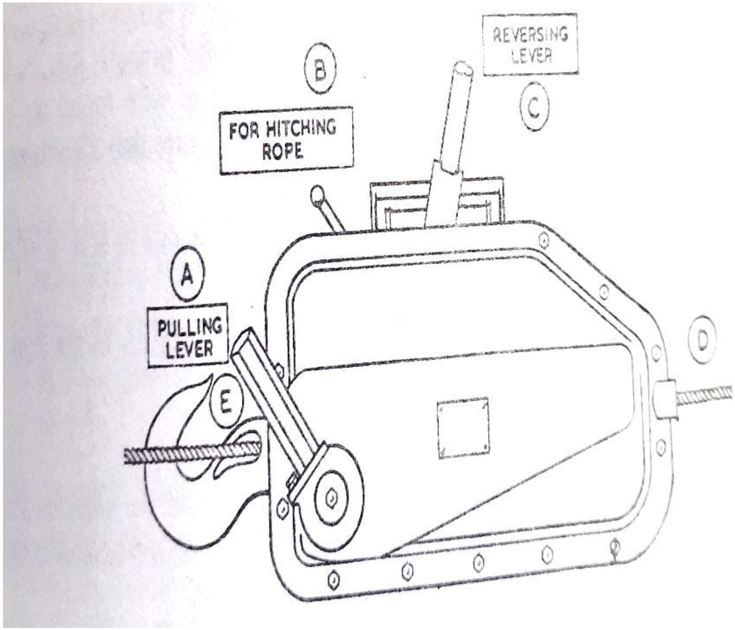
(iv) The machine unit consists of a steel enclosing two pairs of automatic jaws which grip the cable passing through the casing. These two pairs of jaws are moved in opposite directions by means of linkage when the handle is operated backward and forwards.

(c) **Operation**

(i) **Forward and lifting movement**- When the handle is put on the lever at the side of casing and is moved towards the hook, the pair of jaws fixed to the crank shaft move in the same direction, gripping the cable and carrying it forward. Simultaneously, the other pair of jaws, actuated by connecting rods fitted on the same crank shaft, moves away from the hook, sliding along the cable. When the handle is moved in the opposite direction. the pair of jaws fixed to the crank shaft moves away from the book, sliding along the cable, while the other pair of jaws moves forward in its turn gripping and carrying the cable in the same direction as before and pushing it through the first pair of jaws in which it slides, and so on. The alternating operation of the handle results in a hauling or lifting movement of the cable of about 2 ¾ in. for each complete forward and backward stroke of the lever, which with normal operation on a light load results in a travel of about 11 ft 6 in. per minute. This unit provides a mechanical advantage of 1:43. Its size is 24 in. x 12 in. x 6 in. wide and it weighs 19 kgs. Its 5.W.L. (Safe Working Load) capacity is: pulling upto 1680 kgs lifting upto 1120 kgs.

(ii) **Reverse or lowering movement**- By transferring the operating handle to the lever on the top of the casing, a reversing action is obtained. This passes the cable through the machine in the opposite direction and enables the load to be lowered. The cable is under constant tension while the load is on it and does not jerk or slip during the lowering Any jerky movement will be due to lack of lubrication, a fault which should be rectified immediately.

(d) Operating instructions-The following operating instructions should be rigidly followed while working with a Tirfor :-"



Tirfor Operation

(i) Pull lever "B" firmly towards hook on machine, until it is seated in the notch.

(ii) Push the rope into the machine at "D" until it protrudes through the hole in the hook "E".

(iii) Pull the rope through the machine until the desired length is reached.

(iv) Place lever "B" back into the operating position-this is done by lifting the lever out of the notch and allowing the spring inside the machine to carry it into its operating position.

(v) The rope is now firmly gripped in the jaws of the machine. To pull the rope through the machine, place telescopic operating handle on lever "A" and move it along the direction of the rope. The rope moves through the machine on both forward and backward strokes of the lever.

(vi) To reverse rope through the machine, remove the telescopic handle from "A" and place it on lever "C" and move it again in the direction of the rope. The rope is paid backwards through the machine on both strokes of the lever.

(vii) To remove rope, pull lever "B" towards hook as in (i) and pull rope through the machine.

(viii) If the operator cannot move the load with the telescopic operating handle fully extended, the load is too great for the machine, and the snatch lock supplied should be used to increase the machine's power.

(ix) Always use slings of sufficient strength to withstand the load.

(x) Keep the wire rope wound on to the reefer when not in use.

(xi) Never allow any kinks in the rope to enter the machine as this causes internal damage.

(xii) Only use the wire rope supplied with the machine.

(xiii) Do not leave the release.

(xiv) in its release position when the machine is not i use as this will shorten the life of the springs.

(xiv) Never operate A and C at the same time as this will cause internal strain.

(xv) Never anchor the machine by the tip of the hook, always use a sling

(c**) Care and maintenance**

(i**) Before using the machine**

(aa) Check wire rope to see that it is free of kinks and broken wires. Never use damaged rope as this jams inside the machine.

(ab) Put rope in machine and move it to and fro with levers A and B, this movement should be easy and free from jerks.

(ac) Make sure that the machine is lubricated correctly.

(ii**) When using the machine**

(aa) Should the machine become filled with dirt from the debris it must be immersed in a bath of paraffin and shaken well. This operation must be repeated till the din or debris dust is removed. The machine must be well lubricated before use.

(ab) Should the machine become jammed with small pieces of debris or dust, the casing bolts must be removed and one half of the casing should be lifted off The debris or din can then be scarped out of the machine. When the casing is replaced ensure that the cross bar on the spring tubes always fits properly into the slots or both casings. This can be done by looping a piece of wire round the bar and holding it in position until the bolts are fitted. Make sure that all nuts and bole are replaced and properly tightened.

(ac) Should the motion become jerky when lowering, this is due to lack of lubrication and the machine should be oiled immediately.

(iii) **After using the machine**-The wire rope must be coiled back on to the rope reefer.

(iv**) Examinations at monthly intervals**

(aa) Check for went or misuse.

(ab) Make sure that the rope hook is properly fastened on the rope.

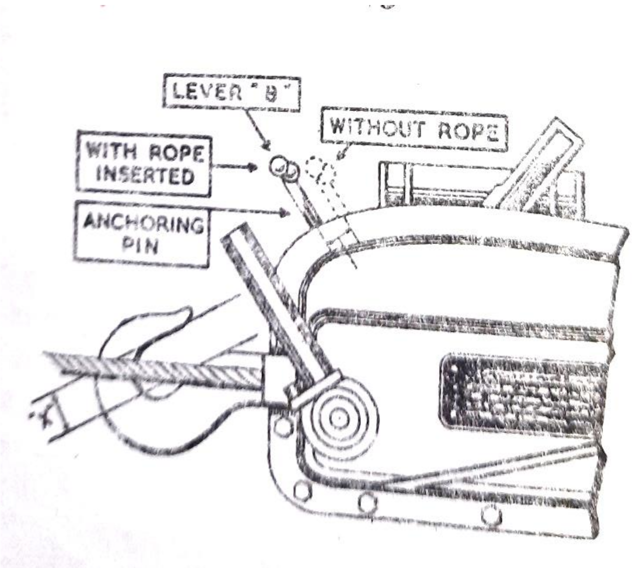
(ac) Measure distance "X" on rope hook and anchoring hook, if it is more than 2 ¾ in the hook has been strained and should be replaced.

(ad) Make sure that the nuts and bolts on the casing are fitted and properly tightened

(v) **Monthly check on wear of machine jaws**

(aa) Remove wire rope from the machine and let the release lever "B" return to its normal position.

(ab) Mark this position on the casing.



(ac) Pull lever "B" forward into its groove, and feed rope into the machine.

(ad) Return lever "B" to its normal position with the rope in the machine, as though the machine was about to be used.

(ae) Mark the new position of lever "B" on the casing.

(af) There will now be two marks on the casing. The distance between these should never be less than ½ in. if less it is a size of excessive wear on the jaws and these should be replaced.

(vi) **Lubrication**

(aa) Heavy gear oil should be poured into the slot at the top of the machine. The machine should then be shaken to allow the oil to reach all working parts, the surplus oil being drained off through the rope holes.

(ab) Oil regularly through the oil holes which are situated on both sides of the lever shaft A.

32. **Snatch blocks**

(a) **General**-Special snatch blocks are supplied for use in conjunction with the lifting and hauling machine. The blocks so supplied are of suitable diameter to suit the steel cable.

These are used principally to change the direction of pull, or to act as a single pulley when raising or lowering a load. Each snatch block weighs 7 kgs. approximately, and two such blocks are carried forward with each machine.

(b**) Operational uses**

(i) As a device for lifting or hauling the machine has innumerable uses and applications. Being light and compact it can be attached to any convenient holdfast or hung from overhead beams, or girders, slung from or attached to derricks or sheer legs, or even attached to the load itself if the cable end is anchored to an immovable object.

(ii) The 60 ft. cable enables the load to be lifted, lowered or hauled considerable distances without changing the position of the machine, and in conjunction with the snatch blocks, permits the most convenient position to be selected for fastening the machine, while the rope can be taken over the pulleys, through window or door openings, or down through floors to wherever the load may be. It can also be passed over a block at the head of a derrick or sheers to obtain height for raising loads such as blocks of masonry or for erecting tall poles or posts.

(iii) The principles of its application have been illustrated in the diagram.

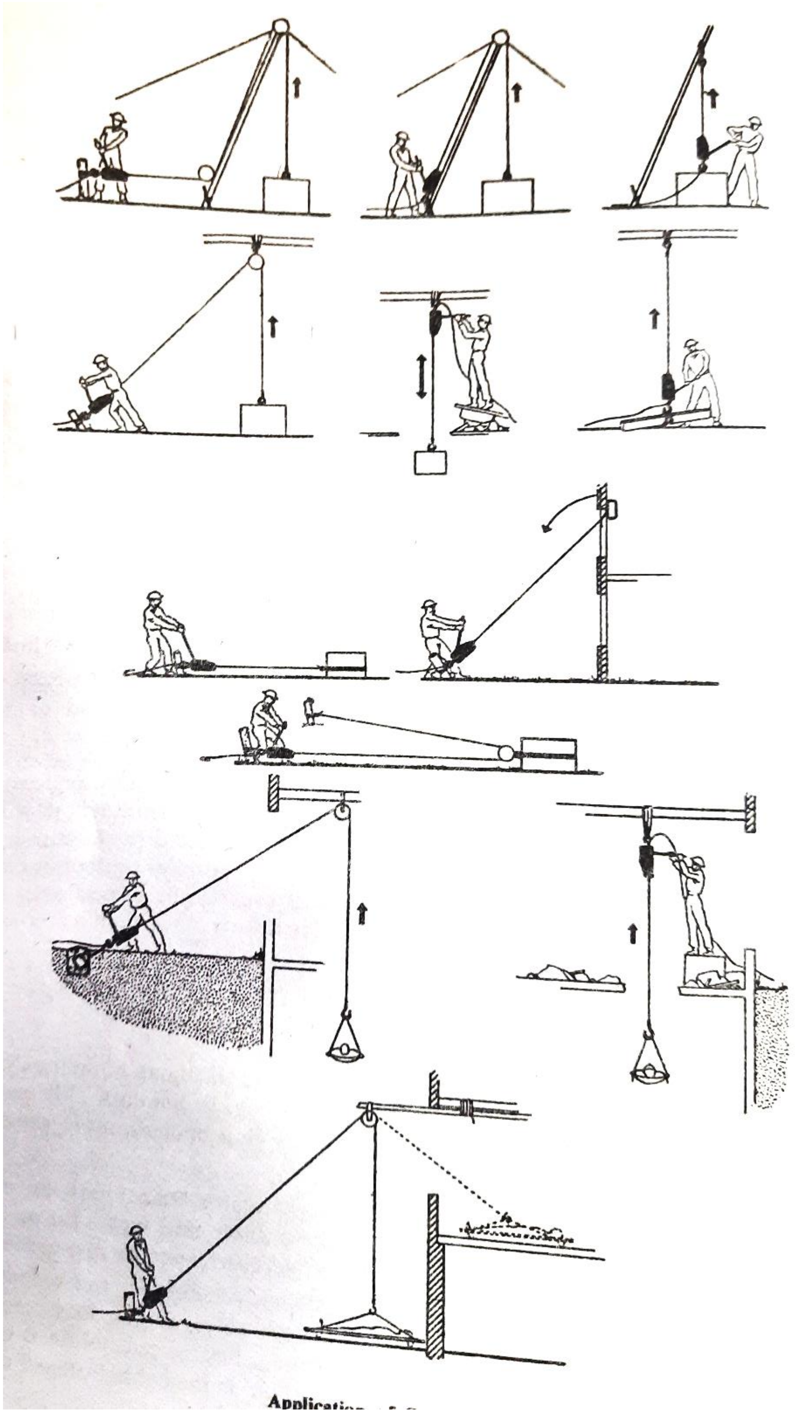
(c) **Anchoring the machine**

(i) The efficiency and indeed the safety of all these applications of the hauling and lifting machine depends upon the security of the anchorage or holdfast. This may be anything sufficiently strong or immovable, but it must be firm enough not to show any signs of failure under load.

(ii) Secured near the base of stout posts, lamp standards, stanchions, by means of wire bonds, the machine will be able to haul in its cable and move, lift or lower its load without fear of sudden failure. Lashed to an overhead beam or spreader across joists, it can be operated in basements or between floors. Attached at convenient positions on derricks or sheer legs, fastened to beams or spreaders, across door openings, in road manholes or behind pickets, anchored to strong, improvised holdfasts of crowbars or stakes, the machine will be ready to work as soon as the cable fastened to the load has been passed over any pulleys being used and threaded through the hauling and lifting machine.

(d) **Application of equipment-**

Applied to rescue operations the systems indicated by the line diagrams above can be utilised in a great variety of situations depending upon the circumstances prevailing and the problems involved. The following photographs illustrate some of the methods of using the equipment.



Application of Snatch Block

33. **Pull lift**

(a) **General**-In an emergency it might be necessary to utilise the pull lift which is a standard item of rescue equipment. While it cannot be adapted to as many varied tasks as other equipment, it can nevertheless play an important part in association with derricks and sheer legs, or on its own, with fibre or steel ropes.

(b) **Operation**-The pull lift works on the ratchet principle and has a chain 6 feet long. It equally convenient for use in hauling or lifting, and its small size, small weight and simple working makes it a popular tackle for short hauls or lifts. One hook is "fixed" to the head of the tackle and another hook "runs" on the end of the chain. If the tackle is operated "with load" then, when "hoisting" the pawl rod lever is turned so that the marking "UP" is visible; and, when, "lowering" the pawl rod lever is turned so that the marking "DN" (down) is visible. In both cases the lever must be seated in the slot of the handle of the tackle and upward or downward motion is obtained by operating the handle with a pumping action. In either hoisting or lowering, this action should be with the effort applied on the downward movement of the handle and with the upward movement free; if the opposite action is obtained, the handle should be turned through 180 degrees around its own pivot, which will permit the reverse movement. In hauling, the effort should be applied when the lever moves towards the operator. If the tackle is operated "without load", then the pawl rod lever should be turned to its neutral position, i.e. midway between "UP" and "DN". Turning the side hand wheel will raise or lower the empty hook to the desired position. When pulling on the chain. the two lines of chain should be grasped tightly with one hand and the hand wheel turned with the other hand to free the load brake; the chain should then be pulled in whatever direction is required. The hand wheel should always be used instead of the handle when operating without load.

(c) **Maintenance**-Oil holes are provided and it is most important that light machine oil be applied frequently: the ratchets require a heavy grease. The chain should be kept clean and lubricated with machine oil. When using the tackle, the running hook should never be jammed up against the head; if this does occur, the lever should be set in "DN" and the handle tapped with a hammer.

34. **Winches**

(a) **General**-Winches on tow trucks, wreckers and rescue squad vehicles are extremely useful for lifting victims from ditches and other excavations. However, a snatch block may be required to allow the pull to be in the right direction. A winch in its simplest form is a reel which can be turned in either direction by hand cranks. The mechanical advantage gained by this machine depends upon the diameter of the winch drum and the length of the crank arms; the smaller the drum and the longer the crank arm the greater will be the mechanical advantage, and this can be further increased by incorporating gearing between the cranks and the drums. There are two types of winches:

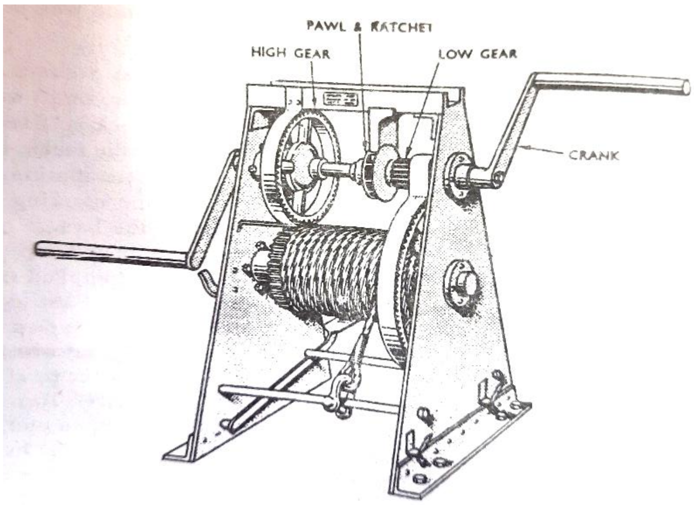
(i) Hand winch.
(ii) Power winch.

(b) **Hand winch**-This winch is used to lift or pull a heavier load by using mechanical advantage. Winch should be kept on a "hard standing" (stable) and should be at a right angle of the pull. SWR should pass below the drum. The end of the winch rope is secured to one end of the drum, and the rope is wound on the drum as it is rotated; care should always be taken to ensure that the rope is wound on right across the drum, so that each new turn lies snugly against the last. Hand winches are always provided with a pawl and ratchet wheel on the crank shaft to prevent the winch from taking charge if the load becomes too heavy to hold by hand; the pawl should always be engaged when the winch is used for hoisting . Some of the precautions to be taken while using a hand winch are:-

(i) Before loading the winch the pawl should be engaged; brakes applied and load placed between gear wheels.

(ii) Use handle during loosening.

(iii) Engage pawl while pulling.



(c) **Power winch**- Power-driven winches, which are mostly electrically-driven differ widely design. Various forms of drive, clutch and brake are fitted, depending on the use for which the winch is intended. They are usually provided with two warping drums driven off the winch motor and fined one on each side of the main drum; these are used for hauling ropes hawsers and the running rigging of the derrick. Power winches are of the following types: -

(i) Vehicle winches

(ii) Hyster winches,

(iii) Wild kite balloon winch used in captive ferrying.

(iv) Air hoist winch.

35. **Cranes**

(a) **General**-It is a machine for raising, lowering or placing in position heavy bodies. Such appliances have been in use of simple construction and actuated by manual or animal power. Modern cranes are worked by steam, hydraulic or electric power.

(b) **Types of cranes**

(i) **Derrick crane**- Derrick cranes have an upright member pivoted at the ends, the top being maintained in position by two raking members anchored at their lower ends.

From the foot of the derrick slopes a raking jib, guyed at its upper end to the derrick top. suitable crab and lifting tackle being provided.

(ii) **Portable crane**- Portable cranes are mounted on a carriage running upon rails. The jib is tied back to the upper part of a frame turning horizontally upon a pivot. The rear end of the frame is carried back to support the crab gear, which, with supplementary weights, balances, in whole or in part, the load to be lifted. Steam power is also used to operate such C.s a vertical boiler and engine, with the necessary gear and winding drum, being substituted for the crab. Jib Ca are also mounted on specially constructed motor vehicles.

(iii) **Gantry crane** -Gantry cranes consist of girders mounted on end wheels, carrying a crab, and are able to lift and transfer loads to the limit of the gantry run. The crab is made also to travel along the girders, giving a double motion.

(iv) **Goliath crane** -These have power appliances for lifting, mounted and running up girders with rightly framed legs either end supported by wheels rating upon rails along which the whole machine may move. They are used in the shifting and setting of heavy blocks in harbour work, or other heavy operations.

(v) **Titan crane** -They are used for similar purposes have horizontal girders, capable of swivelling upon a turntable which is mounted at the top of a travelling sub-structure. At one end of the double girder is the power plant. By an ingenious arrangement the load can be moved along while hanging from the arm of the Titan, remaining at the same level, rising or falling as desired.

(vi) **Hammer headed crane** -Hammer head cranes are similar to Titan crane but work on a fixed tower.

(vii) **Hydraulic crane** -Hydraulic cranes, largely used about docks, are simple machines operated by water pressure through the medium of a ram having pulleys, served with a chain or rope passing over the head of a projecting jib, which may be swan necked in form.

PICKETS AND HOLDFASTS

36. **General**-Pickets and holdfasts are used in rescue work for the purpose of making fast a line, a rope, a wire rope or chain which will be under strain. They fall within two main clauses: -

(a) Those found in situ on the site, e.g., reinforced concrete or metal standards, gate posts of slid masonry, metal frame work of buildings etc.

(b) Those which have to be set up e.g., by use of pickets, beams set in to water gutters or man holes in the street and wedged in position, baulks of timber placed across opening in buildings.

37. **Pickets** -Pickets should be of sound timber, if possible, of ash which is not only hard but has sufficient resilience to "give" rather than to snap as a softer wood might do. In most cases 5 feet is a suitable length, with a diameter, if of ash, of 3 inches, but if of softer

wood a diameter of 4 inches. and over may be necessary. Pickets used for training which may need to be used time and time again should be carefully selected and will have a longer life if sharpened at the driven end, and bound with wire or an iron band at the head to prevent splitting by being frequently driven in. As regards pickets generally, a picket in soft ground will be pulled out if subjected to too great a load, but in hard ground it will break off at ground level. The picket is normally the weakest part of any guy, etc. and should be carefully watched throughout the operations, since it will give an early indication of any excessive strain on the guy. Failure by pulling out usually occurs gradually, but breaking of the picket is liable to occur suddenly. In driving pickets of different sizes, the strongest should be nearest the weight. Whenever possible, they should be withdrawn in the same direction as they were driven. They should never be loosened by hitting them sideways, as this may break them.

(a) **Driving in a picket** -The photograph below illustrates a single picket being driven in and the right way in which it should be held by a lashing line so as to drive it at the correct slope in one direction and at right angles to the line of the pull. In ordinary soil pickets can be grouped for holdfasts for strains up to 2 tons. They may be used as single pickets as shown here, or may be formed into a holdfast arranged as a series of pickets in the line of pull. The pickets should be driven into the ground to appear upright when viewed from the front-and at a slope equal to 90 degrees to the line of the pull when viewed from the side as shown here. Normally, for security, they should be driven two-thirds of their length into the ground. When used to provide anchorage for a guy, for instance from a derrick the guy should be made fast to the picket with a round turn and two half hitches. a single ash picket of 3 inches diameter properly driven into good ground can normally be expected to take a safe load of 400 kg. For greater loads a combination of pickets should be arranged and these can be formed in line as one behind one, one behind two or one behind two behind three, according to need, know respectively as 1and 1,2 and 1 the strongest picket always being nearest to the weight of load being taken. The lashings connecting the pickets should be at 90 degrees to the pickets and should come from near the head of the picket in front to ground level at the backing-up picket. This determines the distance between the pickets, which however should never be less than 3 feet apart. When sound pickets are properly driven into good grounds the safe loads that they can normally be expected to take care are:

(i) Single picker	300-400 kgs
(ii) 1:1 picket	600-800 kg
(iii) 2:1 picket	900-1200 kgs.
(iv) 3:2:1 picket	2400 kgs.

(b) **Driving a 1:1 picket** -To lash 1 and I picker holdfast using 40 foot 1 ½ inch lashing lines make a clove hitch near the head of the front picket leaving enough running end to ensure that when this is married to the line, the twisted ropes will reach to and round the base of the backing-up picket. See Fig. "A" Make four to six turns around both pickets "marrying in" an additional lashing line, if necessary, Fig “B” shows this. Before applying frapping turns round the lashing, tighten up the turns by pulling on alternate lengths of lashing from each side, working from the first to the last turn put on.

Two men bracing themselves with their feet together can quickly and efficiently apply the necessary forces to tighten the turns.

The 1 and 1 picket holdfast lashing is finished off by winding frapping turns around the turns, using up whatever spare rope is left, and finishing with a clove hitch around the lashing Such a holdfast will take a load of from 600-800 kgs.

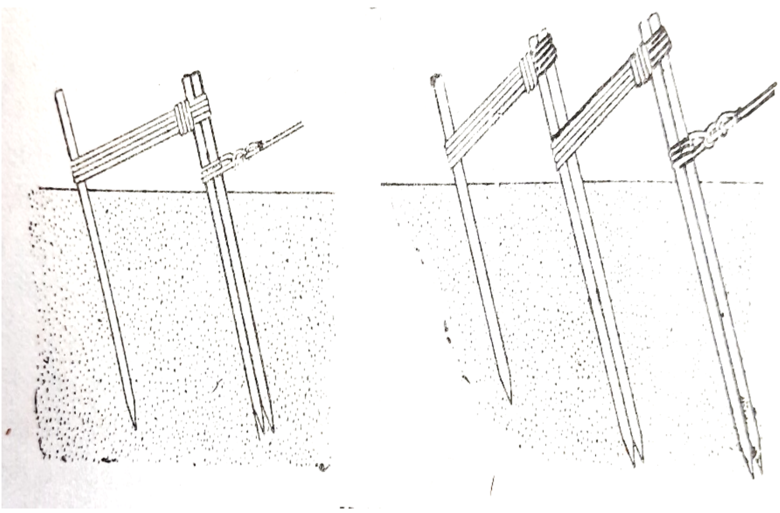
(c) **Driving in a 2: 1 picket**-A two and one picket holdfast will take a load of 900-1000 kgs, and is constructed as shown. The front pickets are driven in side by side close together, and the hacking up picket at least 3 feet behind. The lashing is made as previously described, and all turns must be tightened before the frapping turns are put on. The guy is attached to the front and stronger picket by a round turn and two half hitches.

(d) **Driving in a 3:2: 1 picket**- A completed 3. 2 and 1 picket could be expected to take a load up to 1000 kgs, if the pickets are sound and properly driven into ground and securely lashed. Care should be taken, in setting out, that the pickets are in a straight line with the direction of the line of pull.

38. **Holdfasts** -Holdfast is an arrangement made by pickets or other materials to hold or take strain. They can be classified into three categories, i.e., man-made, natural and improvised.

(a) **Man-made**

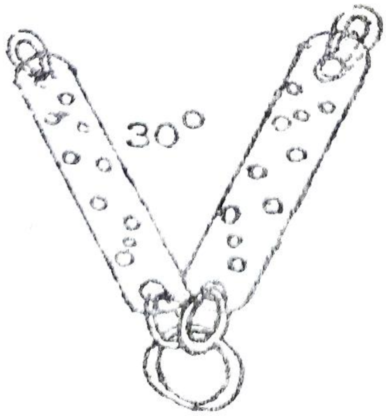
(i) **Picket Holdfasts**-May be used in ordinary soil for pulls not exceeding two tons. The normal picket is an ask stake 5 ft long and 3 in. in diameter, with one end pointed (and, when possible, shod with iron) and the other end found with an iron hoop: it should be driven to a depth of 3 ft at an inclination of about 20 degrees with the vertical. Pickets may be used singly or lashed together in combination of one-and-one, two-and-one, or three-two-and-one, as shown in fig. below.



Holdfasts

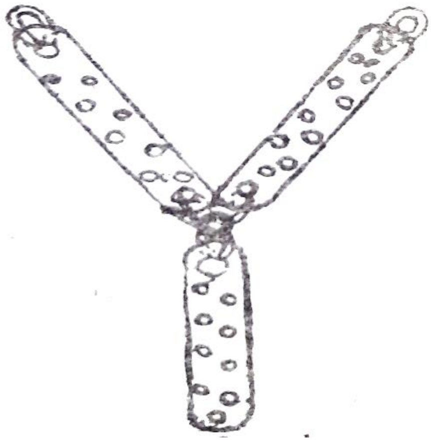
(ii**) Ordnance pattern holdfast** -This holdfast is an ordnance item consists of an iron shell with slots through which number of crowbars can be driven to fix it to the ground. Number of these shells can be joined together to form various shapes to increase the strength of the holdfast. This holdfast can be arranged in the following manner.

(aa) **V shaped**-The two arms are placed at an angle of 30 joined by a shackle. It can sustain a pull/weight of 2000 kgs in hard ground.



“V” shape

(ab) **Y shaped/three legged holdfast**-This consists of three individual of holdfasts joined together by means of shackles and fixed to the ground by means of crowbars. It can sustain of weight of 3000 kgs.



Three Legged

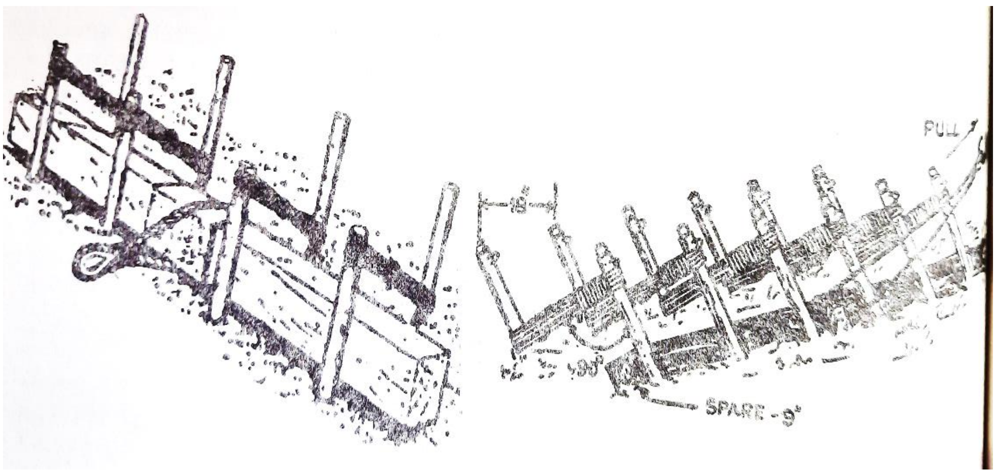
(ac) **Tandem-** This consists of two holdfasts joined together by shackles in a straight line/tandem and fixed to the ground by crowbars. It can sustain a weight of about 2000 kgs.

Tandem

(b) **Natural**-At times the rescue party members have to depend on natural objects to act holdfasts e.g. trees and boulders available at the site. However should ensure that these objects are firmly embedded into the ground before use. However it may be difficult to assess the load bearing capacity of such holdfasts.

(c) **Improvised**

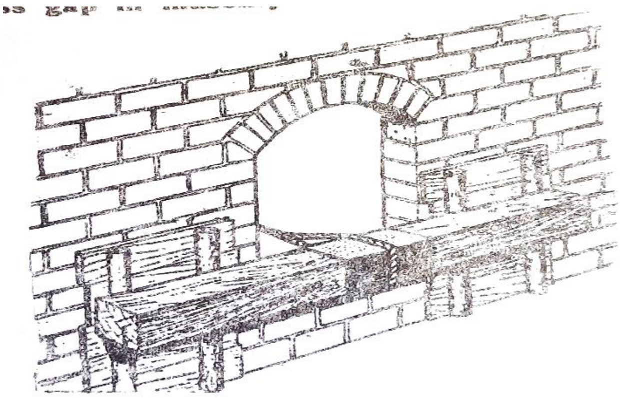
(i) **Bulk and picket holdfast** -Baulk and picket holdfast consists of a baulk of timber placed behind a line of driven pickets which are backed by another line of picket, may be used for pulls of between 2 and 10 tons. Only two lines of pickets should be used, driven in in combinations of one-and-one or two-and-one, with each combination at least 18 in. from the next. A three-two-one combination of pickets should not be used because of the difficulty of driving the pickets so that each will bear its fair proportion of the stress. The front row of pickets should be exactly to line so that the stress on the baulk is divided equally among them, and the ground under the baulk should be cut away to allow the face of the baulk to bear fairly against the inclined pickets. The baulk should be well parcelled where the strop passes round it.



(ii) **Baulk holdfast** -These can be prepared by using varieties of structures both natural and artificial ones.

(aa) Baulk across two trees.

(ab) Baulk across gap in masonry.



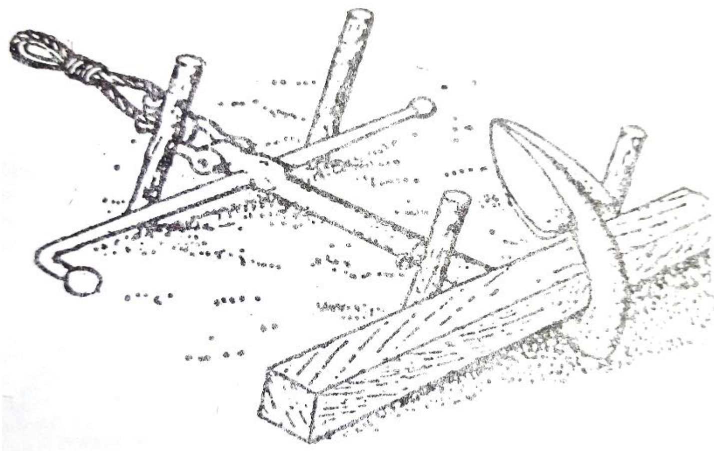
(ac) Baulk across a window.

(ad) Baulk across a manhole.

(iii) **Lamp post as a holdfast**

(iv) **Buried holdfast** -A buried holdfast, used for pulls of over 10 tons, consists of a baulk or baulks of timber hid in a trench and then covered with well-rammed earth. The teach should be 2 ft longer than the baulk and have a vertical face; its depth will depend on the nature of the soil and the pull which the holdfast is required to withstand. A subsidiary trench to take the strop must be cut, as shown in fig below its slope should not be steeper than one in three and chocks should be placed to support the baulk clear of the bottom of the trench to enable the strop to be passed. Planks can be laid vertically and horizontally between the baulk and the face of the trench to distribute the stress over a greater area.

(v) **Anchor holdfast**-An anchor holdfast consists of an Admiralty pattern anchor embedded and supported by pickets, as shown in fig below. If the pull is horizontal it



Anchor holdfast

will take a stress up to the strength of its ring, but it is not very suitable as the holdfast for a guy, because the upward pull of the guy tends to dislodge the anchor, When an offshore underwater holdfast is required for the fore guy of a derrick or sheers the anchor should be laid in a position which gives the guy plenty of scope, and its angle of slope should not be steeper than one in three; that part of the guy which will be under water should be of chain. Backing one anchor with another gives greater holding power, provided that the anchors are well separated.

DERRICKS, SHEERS AND GYNS

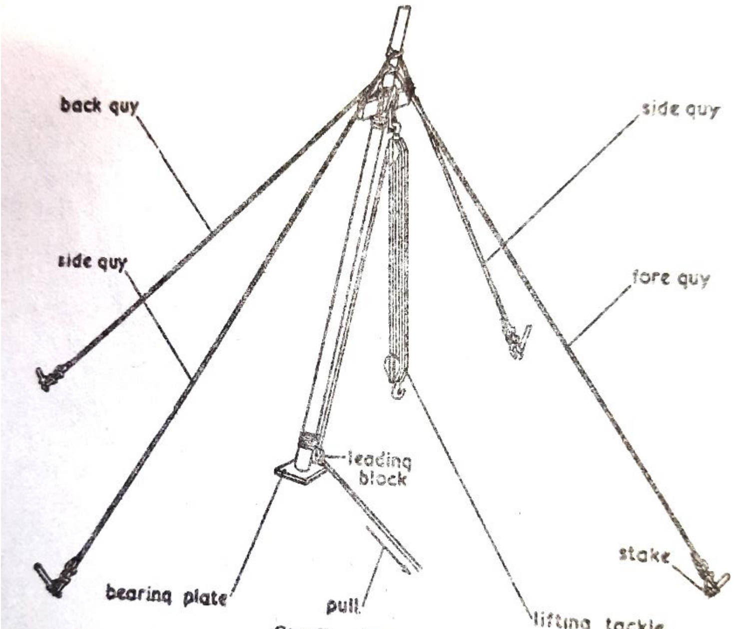
39. **Introduction**-When no suitable crane for lifting a heavy object is available some form of derrick sheer or gyn must be rigged for this purpose. These are used with tackles for lifting and lowering heavy weights each apparatus being used in a different way.

40. The derrick is a single upright spar; the swinging derrick consists of an upright spar with a swinging boom pivoted at its foot. Sheers consists of two upright spars with their heads lashed together and their feet splayed out. A gyn is a tripod by three spars with their heads lashed together. A ropeway consists of an overhead jackstay of rope set up between two sheers, or gyns, along which a travelling block is hauled back and forth.

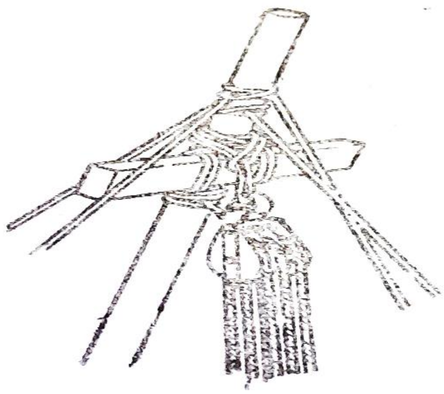
41. In choosing poles for such apparatus, it is important to ensure that they are long and strong enough to permit the load to be lifted to the required height after allowance has been made for the length of the tackle when chock-a-block, plus the length of the sling or chain in use, the height of the object to be lifted, and with sheer legs and gyns, additional allowance must be made for the slope of the legs.

42**. Standing derrick**

(a) **Description** -A standing derrick is a single spar or pole (or two more lashed together for strength) with the butt on the ground on a sole piece and the pole held vertical by three, or sometimes four guys. The weight can be lifted and moved to the right or left and to the front, but only to a limited distance. To support the lifting tackle and to prevent it from binding on the derrick pole a short crosstree (or crosshead) about 18 inches long is affixed to the derrick pole by a square lashing with rope or wire bond. The crosstree should not be shouldered or bolted to the upright as this weakens both crosstree and derrick pole. Its normal position is from 1½ to 2 feet from the top of the pole, but in all cases, it is advisable to have it fixed as far down the pole as will give sufficient room to lift the weight the required distance. With any particular pole the shorter the length of pole bearing the load, the greater the load it can carry within the limits imposed by the type and size of pole in use.



Standing derrick



Head of Derrick

The major parts of a derrick are:

(i) **Gays**- When using 40-foot 1½ inch lashings for guy lines, the opposite guys are joined together by a reef knot or double sheet bend if the ropes are wet and the ropes are attached to the top of the pole by a clove hitch. When the 200 foot 2 inch rope is used as a fore and back guy it should be attached to the top of the pole by a clove hitch made in the centre of the rope. If it is impossible under certain circumstances to use a guy rope, a "lazy leg" may be used. This is done by lashing another pole to the pole of the using the diagonal lashing.

(ii) **Pickets**-The distance of the guy pickets from the foot of the derrick should be equal to twice the height of the derrick if possible but never less than the height of the derrick. Where conditions are unsuitable for the use of pickets, improvised holdfasts may be used.

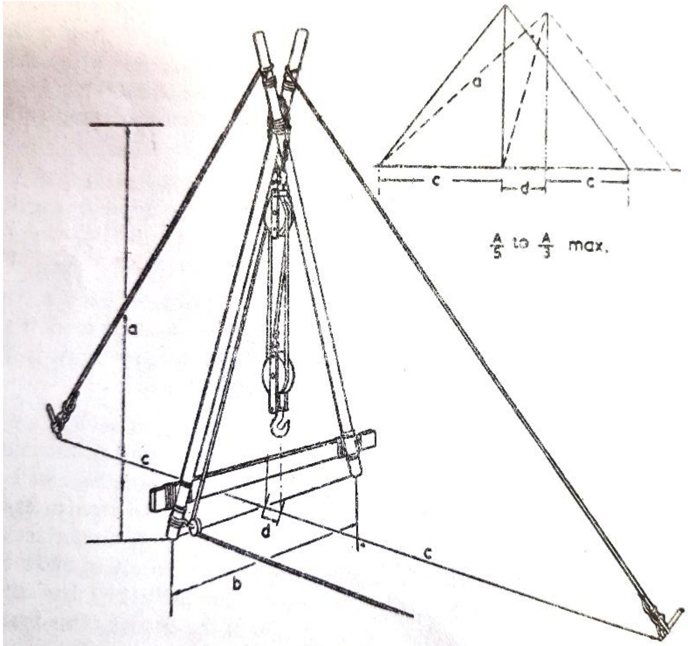
(iii) **Tackle**-The block with the greater number of sheaves is used as the upper block and is attached above the crosstree by a wire bond, sling or chain and the square lashing protected from harm by sacking, etc. The hook of the block must be moused.

(iv) **Footing**-The ground on which the derrick will stand must be firm, or steps must be taken to make it so. It is advisable to form a shallow hole into which the butt will be placed. If the ground is too soft to withstand the pressure of the butt, a footing of baulks of timber may be necessary, so constructed as to spread the load over a sufficiently large area of ground.

(b) **Layout and preparation** -Having chosen the position for the foot of the derrick, allowing for any necessary luffing, the points at which guy pickets will be driven in should be selected. After preparing the derrick, the tackle should be overhauled to the required length and the lower block temporarily lashed to the pole to prevent swinging during erection.

(c) **Raising**-The initial raising is done by hand under the Leader's direction. The guy at each picket is controlled by a man, and, as the pole is raised, the stack on the fore guy is taken in. During erection the guys are temporarily controlled with a round turn on the pickets and finally made fast with a round turn and two half-hitches.

(d) **Luffing** -When raising a stretcher or weight over an obstruction, such as a wall, it is usually necessary to luff the pole slightly. When this is being done each guy line must be controlled under the direction of the Leader. Since the men must work in unison the Leader must give precise directions to haul or slacken and must not leave the men to exercise their own judgement otherwise misunderstandings may occur and lead to an accident. The initial luff should not exceed one-fifth of the effective height of the derrick to allow for stretch in the guy lines when the derrick is first loaded. The maximum luff at any time the derrick is in use thereafter must not exceed one-third of the height of the derrick. This limit of incline fixes the distance at which a weight can be picked up.

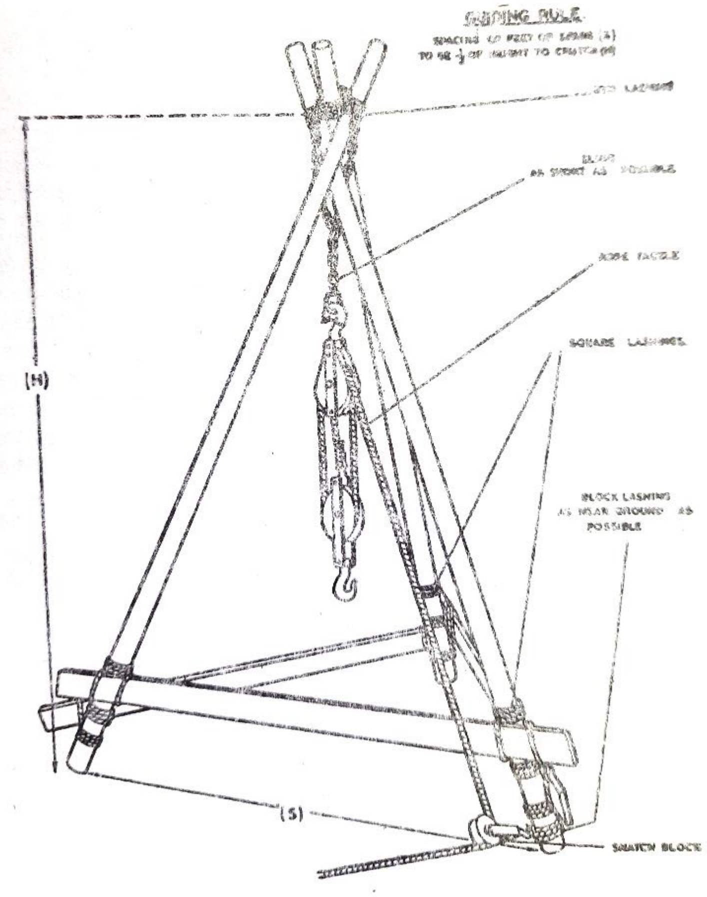


Sheer legs

43. **Sheer Legs**

(a) **Description** -Sheer legs consist of two poles with their butts on the ground and their tops lashed together and held in the air by a fore and back guy, forming an inverted "V" Sheer legs can sometimes be employed where the use of a derrick would be impracticable, but can only be used to move the weight in a straight line by swinging the load between the legs. For a given load, the two spars may each be lighter than the one required for a standing derrick."

(b) **Layout and preparation-**Two poles should be selected as nearly of equal length as possible and laid with their butts flush together on the ground, the tips being raised to a convenient height for working Spacing pieces 2 inches to 3 inches thick should be inserted between the poles and lashed with a round lashing. The butts of the poles should be opened up until their distance apart is about one-third of the length from butt to lashing To prevent the butts from splaying ledger should be lashed on near the butt, or an alternative a 40-foot lashing can be used, fastening it to each leg by a round turn and two half hitches, or holdfasts can be driven in and fastened to each leg. A sling or strop (i. e, a short length of heavy rope or chain) should be passed over the fork or crutch so that it will rest across the poles and not on the lashing between them. The lifting tackle is prepared and hooked into the sling, the lashing being suitably protected. The hook must be moused.



Tripod or gin (gyn)

(i) **Guys-** The guys are similar to those required for a derrick but consist of two only, a fore and a back guy. They should be made fast above the round lashing by clove hitches in such a way that they will draw the spars together when the stress comes on to them i.e. the fore guy to the rear pole and the back guy to the front pole. The length of the guys is similar to those used with a derrick. In certain circumstances a "lazy leg" can be used instead of a guy.

(ii) **Tackle -** A sling or strop is passed over the crutch to take the hook of the upper block of the lifting tackle. The hook must be moused. The tackle is prepared to the required length, and the lower block is temporarily lashed to one of the poles to prevent swinging during erection.

(c) **Raising-**The initial raising is done by hand under the Leader's direction. The guy at each picket is controlled by a man and as the sheer legs are raised, the slack on the fore guy is taken in. During erection the guys are temporarily controlled with a round turn on the pickets and finally made fast with a round turn and two half-hitches. The butt must be placed sufficiently far from any obstruction to permit the top of the sheer legs to be luffed over it

(d) **Luffing-**A sheer leg is luffed by carefully paying out on one guy and taking in on the other. All men must work in unison under the Leader's direction to ensure sound operation and prevent accidents. The amount of luff permissible is similar to that allowed to derricks-i.e. initial luff one-fifth, thereafter one-third maximum.

44. **Gyn or tripod**

(a) **Description** -A gyn or tripod consists of three poles lashed together near the tips and with the butts forming an equilateral triangle on the ground. No guys are required and the space occupied is small, but only a vertical lift is possible. The lifting tackle is suspended from a sling passed over the crook formed by the tips of the spars. The poles used should preferably be of equal length and strength.

(b) **Layout and preparation** -The three poles should be laid out side by side, the butts flush on the ground and the tops raised on a trestle or box. Having placed them they should be marked about 3 feet down from the tip of the shortest pole to show the position of the centre of the lashing. The centre pole should now be removed and reversed with its butt on the ground on the opposite side of the trestle. All three marks should be in line. Spacing pieces i.e. 2-inch or 3-inch thick according to the diameter of the poles-should be inserted between the poles, after which they are lashed together with a figure-of-eight lashing. The two outer poles are crossed until their butts are at a distance apart equal to about half the effective length of the poles, the top of the centre pole to rest in the crook of the other two.

(c) **Raising-**The head of the gyn should be lifted as far as possible by hand and the centre pole brought in to form an equilateral triangle. The butts should be evenly spaced at a distance apart equal to about half the height from the butt to the lashing they must all be on the same level or the weight will be distributed unevenly and the gyn must be placed so that its head is as nearly as possible over the centre of gravity of the load.

Note: Whether a weight is suspended or not the gyn should not be left standing unless the butts are secured against slipping by one of the methods in the sheer legs.

IMPROVISED DERRICKS AND SHEERS

45. **General**-The use of derricks, sheer legs and jibs in conjunction with tackle for lifting and lowering heavy weights has been standardised for many years, but now that the blocks and 3 in, tops have been replaced by the hauling and lifting machine, and poles formerly used in the erection of such apparatus need not be carried forward, improvisation will have to be resorted to if the use of derricks and sheer legs is necessary. Timbers of suitable cross-section and length can often be found on the site of operations and, when properly bound together by means of wire bonds, suitably spaced and wedged tight as described, will form improvised spars of the requisite length and sectional area A derrick spar can be built up of 4 in. x 2 in. timbers, laminated if required to the necessary length and supported when erected by guys, formed of lashing lines fastened to pickets. Three such timbers placed together as described and lashed securely by the wire bonds would form a derrick or stick 6 in. x 4 in. in cross section, or two rafters of 4 in. x 2 in. would make up a 4 m. square, the section used depending upon the load to be tackled. Improvised sheer legs can be built up in a similar manner, or single floor joists of say 7 in. x 2 in. section of the necessary length can be lashed together, erected, and supported by guy lines. In choosing timbers on the operational site for use is the formation of derricks, sheer legs or jibs, it is important to ensure, if one-piece joists or rafters are being selected, that they are long enough and strong enough to permit the load to be lifted to the required height after allowance has been made for the length of the snatch block plus the length of the wire sling, the height of the object to be lifted and, with sheer legs, additional allowance for the slope of legs when erected. When using debris timbers for the construction of built-up spars in the manner suggested, sufficient numbers of timbers should be bound together to obtain the necessary strength, and additional timbers laminated in to provide the requisite length. Care must be exercised in the selection of the timbers to ensure that no splits or fractures are included unless they can be properly secured by additional binding and wedging during the building up of the spar.

46. **Derricks**-A derrick or standing derrick consists of a single spar (or of two or more lashed together for additional strength) with the butt on the ground or on a sole-piece, and the spar held vertical by either three, or preferably four, guys. The weight to be lifted can be raised and moved to the right, left or forward but only to a limited distance. To support a snatch block and to prevent it from binding on to the derrick, a short crosstree or crosshead about eighteen inches long is fixed to the head of the derrick by means of a square lashing with a wire bond or 1½ in. rope. The spar should be slightly raised while the crosshead is being lashed into position. Its normal position is 1 ½ to 2 feet from the top of the spar but it should be remembered that the lower the crosshead can be lashed, the greater the effective strength of the derrick. Before the spar is raised into position it will be necessary to attach the guy lines at some point above the crosshead. The 40 feet 1½ inch lashing lines can be used for this purpose. The two opposite guys are joined together by a reef knot and attached to the spar by a clove hitch. The other two guys are fastened on in a similar manner. When the 100-foot 2-inch rope is used as a fore and back guy, it should be attached to the spar above the crosshead by means of a clove hitch made in the centre of the rope. The ground on which the derrick will stand must be firm, or must be made so, and it is advisable to form a shallow hole in which the butt of the spar will be placed. If the ground is too soft to withstand the pressure of the butt, a footing of timber will be necessary in order to spread the load over a sufficiently large area of ground. The butt should be retained in position on this footing timber by planks or cleats of wood nailed in the form of

a square, or, if there is a danger that the side cleats may be too close to the edge of the timber to enable them to be nailed securely, then it is preferable to form a triangular anchorage around the butt of the spar which can be nailed on well away from the edges of the footing timber. This footing should then be sunk flush into the ground to prevent its movement during the raising operation. A snatch block should be attached to the derrick by means of a wire bond. Alternatively, it can be attached by means of a six-foot chain over some sacking first wrapped round the spar to protect the lashing. The hook of the chain and the hook of the block should be passed through the ring of the chain, and both hooks moused to prevent disengagement before the load is applied. To ensure that the pull on the lifting rope shall be transmitted vertically to the block it is necessary to change the direction of the haul, and this is best done by attaching a second snatch-block near the foot of the derrick. This may be achieved with a strop made with a wire bond. The hook of this block should also be moused.

Having chosen the position for the foot of the derrick, bearing in mind the direction of any necessary luffing, the points at which the guys' pickets will be driven in should be selected; their distance from the foot of the derrick should never be less than its effective height. Normally, a single picket will suffice; if of ash 3 inches in diameter properly driven into good ground, it can be expected to take a load of 6 to 7 cwts (300 to 350 kg.). Pickets should be about 5 feet long and should be driven into the ground for two-thirds their length and at 90 degrees to the line of the pull. Having completed the preparation of the derrick and lifting tackle, the initial raising of it into position is done by hand. Normally two men will be required to raise the spar, with a third "footing it to prevent the butt from jumping out of the hole or timber bearing piece. If the guys have been set out diagonally to the line of raising, the two forward guys will be hauled upon in order to assist in the raising of the spar. The guy at each picket is controlled by a man, and during erection the guys are temporarily controlled with a wound turn on the pickets until the spar is up, when they are adjusted for vertical and finally mi fast to the pickets with a round turn and two half hitches. At this stage of the raising of the derrick considerable assistance is given by the men controlling the forward guys, who, by hauling, take up most of the load. As the spar approaches the upright position all guys must be under proper control by the men at their respective pickets, who will haul in or take up the slack as required to adjust the derrick to its vertical position before making fast their guys. The leader must check on the upright setting of the derrick and instruct the men on the guys to haul in or slacken off as necessary. When moving a weight or raising it or a stretcher over an obstruction such as a wall, it is usually necessary to luff the derrick slightly in the requisite direction. The distance that a weight can be moved is however limited, and is governed by the permissible inclination of the spar. The initial luff should not exceed one fifth of the effective height of the derrick, that is to say if the height from ground to crosshead is 15 feet this would be to a point 3 feet from the base of the spar. This first limit is to allow for street in the guy lines when the derrick is first loaded. The maximum luff at any time thereafter must not exceed one-third of the effective height of the derrick, i.e., 5 feet in the case just mentioned. When luffing is being done each guy line must be controlled, and since the men controlling them must work together, the leader must give precise directions to haul or slacken as the direction of the luff may warrant, and must not leave the men on the guys to exercise their own judgment.

47. **Sheer legs** -Sheer legs, the second type of weight-lifting apparatus to be described, consist of two spars with their butts on the ground and their tops lashed together forming as inverted "V". When raised into position the spars are held up by a fore and a back guy which

can be adjusted to permit the sheer legs to lean or luff. Sheer legs can sometimes be employed where the use of a derrick would not be practicable, but they can only be used to move the lifted weight in a straight line by swinging between the legs.

For a given load, the two spars used for sheer legs may each be lighter than the one required for a single derrick as the load is distributed, but they must be as nearly equal in length and strength as possible. Their butts should be laid flush together on the ground and their tips raised on some sort of support to a convenient height for working. A spacing piece or pieces 2 to 3 inches wide should be inserted between the spars to allow frapping of the round lashing which is used to tie together, and to permit the spars subsequently to be crossed over one another to form the inverted "V". After the spacing pieces have been removed, the butts of the spars should be crossed over and opened up until their distance apart is equal to about one-third of the lengths from butts to lashing. The space between the spars at the lashing enables the knot to twist during their operation. The guys are similar to those required and described for the derrick but consist of two only, a fore and a back guy, and in this case the 100 ft 2 in. rope should be used. They must be made fast to the spars above the lashing by clove hitches in such a way that they will tend to draw the spars together when the stress is upon the guys, i.e., the fore guy will be attached to the rear spar, and the back guy to the front spar. The length of the guys, as for the derrick, should be sufficient to reach the pickets driven at distances not less than one and a half times the effective height

Having completed the lashing and attachment of the guys, a sling or strop, e.g., one of the wire slings or wire bonds or one of the 6-foot chains, should be passed over the fork or crutch. To prevent the sling damaging the rope lashing a piece of old sacking should be draped over the crutch as protection. The snatch block is then hooked into the sling and the hook moused and the hawser of the lifting and pulling machine inserted, the hawser's hook being temporarily lashed to one of the legs pending raising. If it is necessary for a change in direction of the hawser to be made, the second snatch block will have to be lashed to one of the legs just above the ledger, but in some cases the lifting machine itself can be lashed in this position and operated without necessitating the provision of a separate holdfast. To prevent the butts of the spars from spreading apart, a ledger or piece of debris timber should be lashed on near each butt, or as an alternative a 40-foot lashing or wire bond can be used, fastened to each leg by a round turn and two half hitches. Alternatively, holdfasts can be driven in close to each leg and lashed thereto. The initial raising is done by hand under the leader's direction. The butts are "footed" by two men while the spars are raised by two others. The guys at each picket are controlled by two more men, and as the sheer legs are raised the slack on the fore is taken in. During erection the guys are temporarily controlled with a round turn on the pickets, and finally made fast with a round turn and two half hitches. The butts must be placed sufficiently far from any obstruction to permit the top of the sheer legs to be luffed over it. A sheer leg is luffed by carefully paying out on one guy and taking in on the other. The amount of luff permissible is similar to that allowed in derricks, Le. initial luff one-fifth of the effective height, thereafter one-third being the maximum.

SAFETY PRECAUTIONS WHILE LUFFING THE DERRICKS AND SHEER

48. When using the equipment, the weakest guy in the derrick has a safe working load of 125 kg. The guys in the sheers have a safe working load of 200 kg. The load to be lifted must not exceed the strength of the weakest part of the rig. As a precaution against slipping whilst under the load or when being luffed to swing a load to a desired position, the butts of the timbers, etc., used in the construction of sheer legs or derricks MUST be anchored, To

ensure should operation and prevent accidents all men must work in unison under a leader's direction.

All men (with the exception of the operator of the hauling and lifting machine when this is attached to the leg of a rig) must stand clear when a load is being lifted. All men must stand clear when a rig is being luffed; if it is necessary to control the swing of a load this must be done by attaching 40 ft. lashings.

49. **Methods of anchoring batts**

(a) **In soft ground** -A base plate or plates of timber or other hard material should be lashed to a picket or boxed with timber to prevent slipping. The 3 ft. pinch bars carried by each Rescue Party make suitable pickets.

(b) **On firm ground**-The butts should be lashed to pickets (on the inside of the legs where appropriate).

(c) **On hard surfaces**- E.g., tarmacadam, cinder paths, in which it is impracticable to drive pickets. Holes at least 3 inches deep should be cut to position the butts (the greater the width of the butt the deeper the hole required) with base plates if necessary, should the subsoil be soft.

Note: If the surface should be of concrete butts should be lashed back to suitable holdfasts.

SWINGING DERRICKS

50. **Swinging derrick on a tree**

(a) **General**-This derrick is based on a tree. Accordingly, the selection of tree assumes greater importance. Dead trees, cracked hollow or tree with wood peckers must be avoided.

(b) **Equipment**-The following equipment would be required: --

(i) **Ropes**
- (aa) One 2-inch 50-foot to 100-foot
- (ab) One 2-inch 50-foot.
- (ac) Two 1-inch guide lines approx. 60-foot

(ii) **Spars**
- (aa) Two 12-foot to 15-foot
- (ab) Two 3-foot to 5-foot

(iii) **Pickets-Two for anchoring guide lines, etc**.

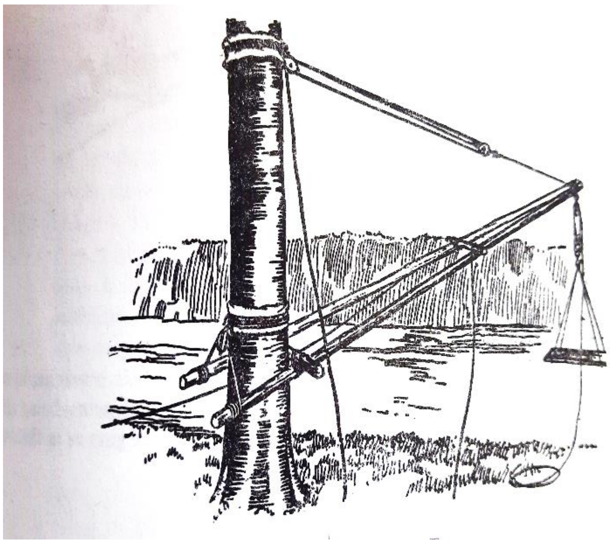
(iv) Lashing
- (aa) Seven 15-foot
- (ab) Three 20-foot

(v) **Block**
- (aa) Two double sheave.

(ab) Three single sheave.

(vi) **Oddments**

(aa) Sacking for tree.
(ab) Plank for chair.
(ac) Sisal for mousing



(c) **Construction**- Following steps may be adopted for construction of improvised swinging derrick:

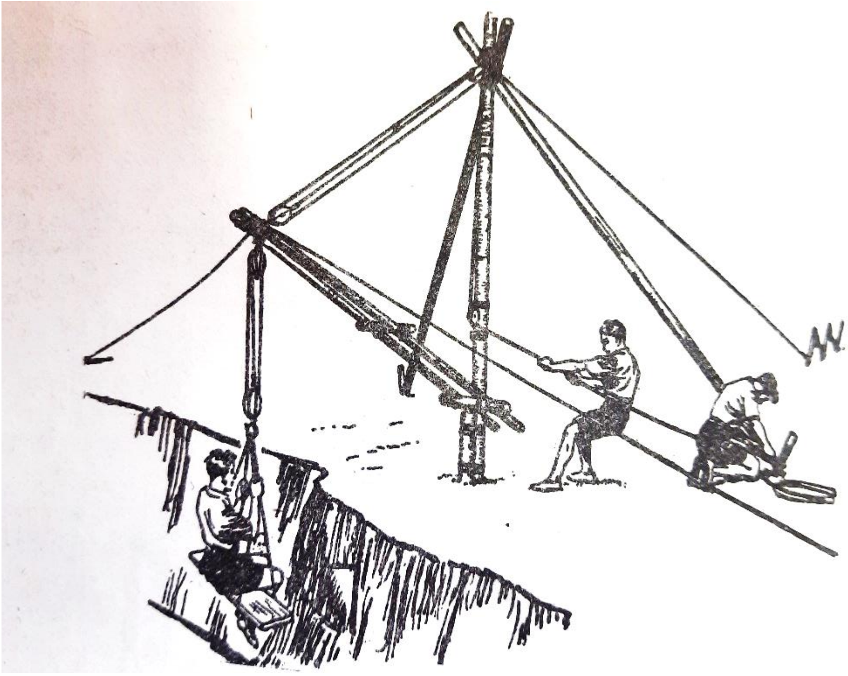
(i) Fix the two pieces of sacking in position.
(ii) Fix the top sacking on with sisal and over the sacking fix a rope straw.
(iii) Make a load carrier.
(iv) Make a jib using a sheer lashing at the top kept apart with a distance piece.
(v) Secure one block by the book to the straw round the highest point of the tree and making fast round the sheer lashing on the jib.
(vi) Secure the base of the jib.
(vii) Finally test lashing and mousing all hooks before use.

(d) **Operation**-The derrick has three separate movements, with the block and tackle fixed on top of the jib we can raise and lower the jib as required. With the ropes fixed to the jib we can swing it from side to side, with the block and tackle fixed to the load carrier it can be raised or lowered.

51. **Swinging derrick**-The swinging derrick is similar to the swinging derrick on a tree. The major two differences are:

(a) The tree has been replaced by a secured spar with good anchorage and with two supportive spars to hold up the main spar. The two supporting spars in turn have to be fixed on ground with pickets.

(b) The other difference is for hoisting drive in a stake or use the pulley-block method.



52. **Ladder as a derrick**

(a) **General**-A derrick can also be prepared from a ladder. Such a derrick is very useful when a ladder cannot be placed against a wall because the wall being weak or not being able to take the thrust of the ladders. The ladder is kept steady by means of guys as in the case of other derricks.

(b) **Equipment**

(i) Ladder extensible 35 ft-one.
(ii) Lashing 1 ½” x 40 ft.

(aa) Three for side guys.

(ab) Two for guide ropes.

(ac) One for stretcher lashing to secure casualty.

(ad) One for fixing the snatch block.

(iii) Ropes 3 inch x 100 ft long-one for use with the pulley.

(iv) Snatch block 3 inch-one.

(v) Ropes 3 inch x 200 ft. long-one as back guy.

(vi) Hemp for mousing-one piece.

(vii) Stretcher-one.

(viii) Improvised stretcher sling-one.

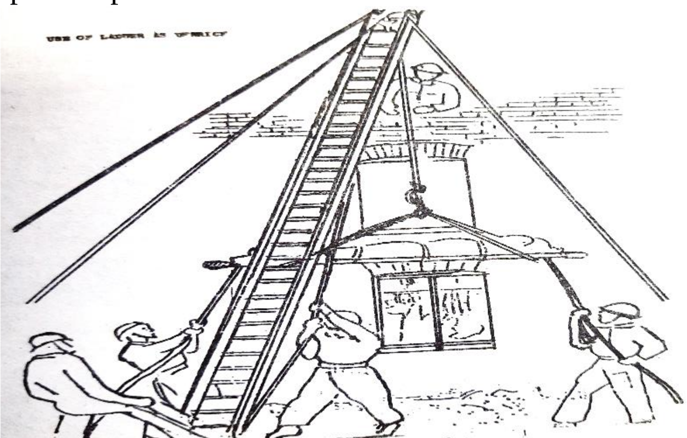
(ix) Blanket-one (or as required).

(c) **Method of erection** -A ladder derrick is to be erected in four stages:-

(i) **Stage 1**-Place the ladder on the ground, foot towards the wall and the reinforcing bar upper-most. The ladder is extended not more than four rungs, so that the guy lines and match block can be made fast below the second rung from the top. When the ladder is raised the reinforcing wire is facing the building as in normal practice. Before the ladder is raised, tie a lashing in the form of a wire bond between the third and the fourth rung of the ladder and fix a snatch block. Pass the 3-inch 100 ft. long rope through the snatch block as the lowering line. Secure the running end to the last rung of the ladder.

(ii) **Stage 2 -**Pickets for the side guys are positioned forward of the foot of the ladder as far as possible, where space does not permit this, the pickets should at least be in line with the wall towards which the ladder derrick is being inclined. Take three 1 ½ " x 40 ft. lashings and join them by reef knots, to form one complete length of rope. The centre of the middle one is then fastened by means of two clove hitches, one on each string of the ladder, in such a way that guys should draw the strings together when in position, for the back guy 3 in. x 200 ft. rope is used. A bowline is formed at one end of the rope with loops around the ladder strings and above the clove hitches of the side guys. The standing part is taken to a picket driven in line with the centre of the ladder. The ladder derrick is now ready for erection.

(iii) **Stage 3**-The ladder is raised to the vertical position and is extended to the required height under the direction of the ladder, the top of the ladder is lowered towards the wall while the strain is being taken by the guy until it is in the required position. The back guy should now be fastened to its picket by a round turn and two half hitches and need not be moved thereafter. The bottom of the ladder must be on a firm foundation and lashed to pickets or otherwise secured to prevent movement. When pickets are utilised, they should be driven as nearly vertical as possible. The ladder should ensure at this stage that there is enough room between the wall and the ladder so that there is sufficient clearance for a loaded stretcher, subsequent luffing of the derrick to get the clearance is not desirable. During the raising and positioning the side guys must be manned. When the ladder is in the required position three guys must be made fast to the respective pickets.



Ladder as a derrick

(iv) **Stage 4**-The casualty is secured to the stretcher in the normal way. The lowering line is fixed to the stretcher sling by means of bowline. Guide lines are fastened to the 'D's at both ends of the stretcher, which will be farthest from the damaged wall. The guide lines are thrown to the men on the ground, to enable them to control the stretcher. The three inch rope is passed under the lowest rung of the ladder, and is paid out by the man footing the ladder and the strain is taken by his mate standing under the ladder. The rope must be paid out hand over hand. The snatch block must be moused. This should be checked before throwing down the guide lines.

(d) **Points to note**

(i) Ensure the ladder is kept with reinforcing bar uppermost, so that when raised the reinforcing bars face the wall, as usual.

(ii) The ladder should not be extended more than four rungs to enable the guys to be fixed before erecting.

(iii) The side guys are made up of three 1 ½ inch 40 ft lashings joined with appropriate knots and tied to the strings by clove hitches.

(iv) The back guy is a 3 inch rope. While erecting most of the strain is taken by this. This rope must be well stretched before use. Use a bowline with loops around the strings and above the side guys. Once it is made fast, do not move it.

(v) Care must be exercised by the leader to ensure that there is enough space between the ladder and the buildings, so that a loaded stretcher can be cleared. He must assess this while erecting, because, once the ladder is erected, no luffing is desirable.

(vi) The foot of the ladder must be secured to pickets or secured otherwise, so that it does not slip. It must be kept on firm ground.

(vii) During the raising and positioning of the ladder the side guys must be manned. These guys must be made fast once the ladder is in the required position.

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CHAPTER 12

RAISING AND SUPPORTING STRUCTURAL ELEMENTS

1. **Introduction** -Enemy air raids may cause such damage as may completely demolish some buildings. However, some structures in damaged buildings may remain dangerously erect capable of falling at any time. Under such circumstances the rescue parties cannot carry out their work without potential danger to their lives. Besides there may be huge damaged walls, buildings and other structures which may be quite beyond the capacity of a rescue party to deal with. This in fact will be the responsibility of the demolition squads who will be specially trained and properly equipped to deal with such problems of demolition of big and dangerous structures. On the contrary it cannot be expected of the demolition squads to go to innumerable places of damage in different buildings to help the rescue parties to deal with small dangerous structures. Thus, it inevitably falls on the rescue party to handle this problem. In dealing with the same any rescue party has the following aims:

(a) To enable the Rescue personnel to carry out their duties in damaged buildings with safety.

(b) To prevent further injury to casualties.

(c) To obviate danger to the public through the collapse of the building into a highway or other public places.

2. It is therefore clear that the rescue parties may be adequately trained to deal with such small dangerous structures as may involve the risks mentioned above. This the rescue parties do mainly by shoring, propping and strutting the dangerous walls of buildings etc.

WIRE BOND

3. **General**-The wire bond is a hemp core galvanized wire rope ¼ inch in diameter, and 15 ft in length. One end is spliced, forming a thimble and the other fused into a ferrule. In good condition it will take a load of approximately 300 kg. It is also known as a scaffold lashing, and is carried in the manpack by each member of the Rescue Section. It can be used for a number of purposes in rescue work beyond its normal use as a lashing. Some of these are given below.

4. **Making of Wire Bond**-A simple method of making a wire bond sling is by passing the running end of the wire through the thimble, around the back of this, and then passing it underneath itself on the front, thus forming a single bend as shown. A longer length can be achieved by joining two or more bonds in a similar fashion. Having made the single sling, it can often be doubled or trebled as required according to the size of the load to be lifted. It should be remembered that the greater the number of the returns of the wire the greater the strength of the sling. In all applications of the wire bond, the wire can easily be straightened after use by applying pressure to the kinks by the thumb and forefinger of the one hand and feeding to this hand by the other.

5. **Making of a Spar**-Timbers can often be found on the site of operations, and they will frequently be 4 in. x 2 in. in dimension, as used in the construction of the roofs of buildings and ground floor joists. Upper floor joists of 6 in. x 2 in. and 7 in. x 2 in. may also be available. When using the smaller sections, the cross-sections of two of the timbers should be equal, and the third should be of a thickness which when lashed to the others should equal their total width, thus making up a rectangular timber. This, and the method of securing these by means of wire bonds using round turns about 4 ft apart, is shown below. The turns are tightened by driving a wooden wedge under them and this should be about half the width of the timber. It should however be ensured that before the spar is made the timber used is properly cleaned to identify any cracks in it.

6. It may not always be possible to find timbers of one length in which case it will be necessary to make up shorter timbers into the length required. This is done by staggering the joints of these shorter lengths as much as possible and placing a piece a board e. g. flooring board, over the joint. The wire bond is then lashed over the board and the joint.

7. An improvised spar can also be used as a lever to lift/ move heavier loads.

8. **Uses of a Wire Bond** -A suitably made wire bond can be used as follows in rescue work:

(a) **Vertical Support**-The wire bond can be used in conjunction with a spar to support an unsafe floor. This can be done by passing the end of the wire bond through a hole which has been made in the floor, around a short timber placed under the floor joists, back through the hole and over a spar positioned on a solid foundation. The sling is then died off in a single sheet bend.

(b) **Horizontal Support-**A firm anchorage is necessary and this may be found to be a door opening some little distance from the unsafe wall. A piece of strong timber is placed across this opening. The running's end of the wire bond(s) is taken round behind this and thence to a timber placed across the unsafe portion of wall. It is passed behind this timber then returned and tied off through the eye in a single sheet bend. A piece of timber e.g. broom handle is these passed through the sling, and the sling twisted by means of this until the timbers behind the door opening and the damaged wall are held firmly in position. The "twisting" timber is then made fast, or anchored by debris at one end to prevent untwisting

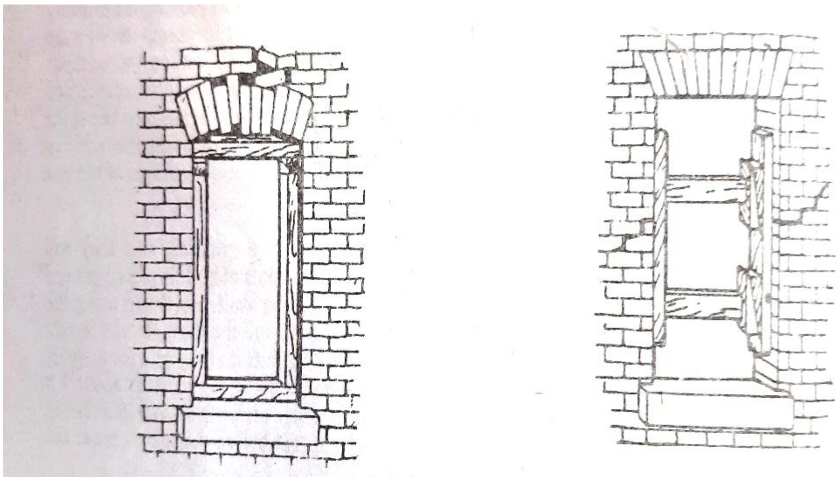
(c) **Lifting**- A floor or heavy load can be lifted by means of the wire bond using this as a sling passed around a spar. The latter will give the necessary leverage for raising the floor or loos the sling is passed under the load to be lifted and the other end over the timbers to be used as lever. A sound wall or upright spar of sufficient thickness will act as a fulcrum. Power is then applied downward by the man to the lever in the normal way, and this has the effect of raising the other end, the lifting being exerted to the floor or load by means of the sling

(d) A similar technique can be applied to lifting a heavy load such as a block of masonry or girder except that in this case the wire bond slings are passed under the weight to be lifted. Fig below shows a 10 ft laminated lever being used to lift a weight of approx. 500 kg.

(e) **Direct Lifting**-The wire bonds can also be used as sling in applying direct lift to a heavy load such as a large piece of masonry or heavy tank which cannot be manhandled owing to in weight and awkward situation e.g., in a confined space such as a narrow area in front of a building. In this case the wire bond slings are passed under the load to be lifted. A piece of timber is inserted under the slings above the load and lifting power is applied by men to this spar.

PROPPING, STRUTTING AND IMPROVISED SUPPORTS

9. **General**-When the walls near windows or door openings are unsafe and are to be shored up, or when heads or sides of such openings are damaged, it is a sensible precaution to strengthen the opening by strutting. Any vertical support to a damaged weak structure is known as propping and the support to the same when given horizontally is known as strutting (Refer figure below).



There are numerous applications of propping and strutting methods which will aid the success of theme work and the safety of those engaged in it. It is very important, however, that all such improvised work should be constructed and erected in accordance with accepted and established principles if the result is to be successful.

10 **Strutting**-The following methods may be used for strutting:

(a) **Windows**-The simplest method when the sides only need support, is to insert two uprights and pinch them into position by driving between them a strut slightly longer than the distance between the uprights which, if the strut a slight bevel at one end, can be securely wedged into position.

Alternatively, upright struts may be secured in position by means of horizontal struts tightened in place by pairs of folding wedges. Pairs, not single wedges, should be used.

If the head has to be supported as well as the sides, timbers will have to be inserted under the head. If it is an arch, these timbers will have to be shaped or packed to fit its entire under side, depending on the shape the arch has assumed when damaged.

(b) **Doors**-Door openings which have been damaged and are unsafe, may be strengthened and
strutted in a similar manner utilising sole-piece, side uprights, head pieces and struts all secured and tightly held in position by pairs of folding wedges.

(c) **Roof**-A collapsed roof can be supported by temporary strutting wedged up with folding wedges from a sole-piece nailed across the floor. Struts and head piece can be inserted under a collapsed floor to form an entry into the void beneath the floor and to enable access to be made without danger of further collapse. A strut inserted under the ridge of a collapsed roof can prevent further collapse while rescue work is effected.

11. **Propping**-A vertical support to a weak structure is termed as propping

12**. Improvised Supports** -Struts and bearers can hold back debris from the crawl way entrance to an opening leading under a collapsed floor, such a crawl way, if kept clear of tumbling debris, greatly facilitates the removal of casualties.

Struts are not the only method of supporting the sides of a crawl way through debris. Figure above shows an iron pipe used as a support wedged at the bottom by a piece of timber "Vee Cut" to grip the base of the pipe, which is held back at the top by a wire bond which is taken to a convenient picket or holdfast.

Simple methods of debris support may often be employed to obviate the removal of much debris. thereby saving time and labour in the approach to trapped casualties.

SHORING

13. **General**-Shoring is the erection of a series of timbers to stabilize a wall or prevent further collapse of a damaged structure that endangers the conduct of rescue operations. Only temporary shoring will be constructed by rescue squads. Shoring should not be used to restore structural elements to their original position. Any attempt to force beams, sections of floors, or walls back into place many cause further collapse and damage. It is important, however, to secure all shoring in position. This must be done gradually and without shock to the structure, using bars and wedges or jacks. Frequently a weakened foundation or damage to the lower portion of a wall makes it unstable; causes of instability in a damaged structure may vary. Since there is no standardized method of approach, situations requiring shoring and the support of walls and floors call for careful planning and good workmanship. The lower part of the wall and its footing or foundation much carry the entire weight of the structure above it. If it is damaged, or is weakened by the removal of an adjacent supporting structure, it may buckle and crumble. Therefore, bracing or shoring on lower part of the wall should be stronger than corresponding work on the upper portions,

14. **Purpose**-The purpose of shoring is not to attempt to force the damaged wall or floor back into its original position, but rather to prevent further movement. Any attempts to force things may result in further damage. All shoring should be placed so that it gives support where support is needed, and consequently consideration must always be given to the loads carried by the damaged wall. Usually, the wall supports an upper floor or floors and the load imposed by these floors must be reckoned with and. where necessary, transmitted to the shoring and by it to the firm support being utilised. The shoring undertaken by rescue parties should normally limited to:

(a) To enable C.D. personnel to carry out their duties with safety.
(b) To prevent further injuries to casualties.
(c) To obviate danger to the public through the collapse of the damaged building into the highway.

15. It follows therefore that the type of shoring the rescue parties must be prepared to erect during rescue operations should be only such temporary shoring as is necessary to meet urgent requirements. In order that it should perform its function, however, it must follow certain accepted principles as applied to permanent shoring, and the knowledge of what shoring does and how it does it is vitally important to all who may have to erect temporary shoring

16. **Material for Shoring**-The materials for improvised and temporary shoring should be obtained from the damaged buildings. Most buildings contain timbers of suitable sizes, especially g two or more, pieces are nailed together to form the required lengths and cross-sections. Such up should always be done with the timbers laminated and spiked together with the joints staggered.

17. **Type of Shoring**-There are three types of shoring in normal use:-

(a) **Raking Shores**

(i) **General**-If a wall is bulging or out of plumb, shoring may be used to brace the wall hold it in position, especially if excavating or tunnelling is being conducted next to it. This type of shoring is called bracing pushing or raking shore.

(ii) **Parts of a Raking Shore**-The principal parts of a Racking Shore are:

(aa) **Raker** -The raker should be approximately square in section from say 4 in. x 4 in. to 6 in. x 6 in depending upon the height of the shore. It can be of solid timber or can be made up different size timbers i.e., two 4 in. x 2 in. joists laminated together would form a 4 in. x 4 in. raker, or three 2 in. x 7 in. joists would make up a 6 in. x 7 in. raker. The centre line of the raker should aim to meet the centre line of the floor at the junction with the wall to be supported. The raker is prevented from sliding up the wall plate by a wooden cleat spiked to the plate. The necessity for speed and the possible instability of the wall will not permit the use of the "needles" found in conjunction with cleats on orthodox shoring.

(ab) **Wall Plate**-The wall plate should be long enough to cover the area of weakness and 9"x3" in sections. The length required for the wall plate having hers ascertained, a suitable piece of timber is selected from that available and prepared. At the correct position previously ascertained by measurement up the wall to the floor line, a wooden cleat is spiked to the wall plate. This is to take the shaped top end of the raker and to prevent it sliding up the wall plate when levered and wedged into position. This cleat should be of sound timber about 9 in. x 3 in. in size and sufficiently long to enable it to be well spiked to the wall plate.

(ac) **Sole Plate**- The sole-plate rests on the ground and acts as a foundation or raft to spread the load from the raker. It must be thick enough to resist crushing by the raker and large enough to distribute the load.

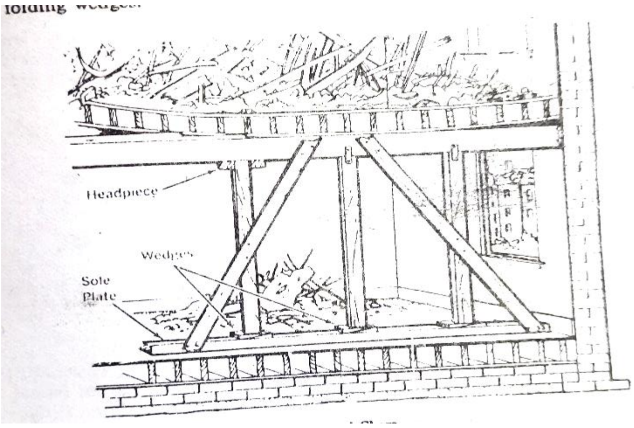
Ranking Shores

(iii) **Method of Erection** -Having selected and prepared the wall plate and taken the additional measurements required, the raking shore must be set out on the ground so that the correct lengths of timbers and the angles of cuts or bevels at each end of the raker can be ascertained. With the wall plate and sole-plate set out temporarily on the ground and kept in position by bricks or pieces of rubble, the raker is temporarily placed into position and the ends marked for cutting to shape. The sole-plate should be set at a slight slope so that the outside angle it makes with the raker is a little greater than a right angle. With the top cleat spiked on, the wall plate can now be placed in position against the wall and held up by a temporary strut. At this point any irregularities in bearing due to bulging can be ascertained and suitable packing pieces obtained for insertion behind the plate to provide a continuous bearing. The sole-plate can now be laid down and, in a similar manner, packed up to provide an even hearing to distribute the load imparted by the raker. It should be packed up to the correct inclination, the external angle being little more than a right angle with the line of the This to ensure that as the raker is levered into position it tightens, making a right angle in its final position.

When on hard ground the sole-plate must be built up to the required slope and secured so that it will not slip when the raker is wedged into position. One method is to drive a metal stake or piece of scrap iron spike at the back of the sole-plate. When in soft ground the earth can be excavated to the necessary slope and the sole-plate set at the proper angle. The top of the raker is now placed underneath the cleat on the wall plate and the foot placed on the sole-plate. The whole structure is then gently levered into the correct position. If, in the case of a laminated raker the centre timber is cut back slightly. this will form a notch which will provide a good bearing for the crowbar used to lever the raker into position. A small rebate in the foot of a solid raker will serve the same purpose. The operation of tightening up the raker must always be done gently and never with a hammer or Such action would transmit shock to a structure already damaged with possibilities of disastrous results. While one man holds the raker tightly levered into position another nails a stout cleat onto the sole-plate behind the raker. Any irregularities in cutting may now be remedied by the use of wedges. To frame and tie the shoring together, struts or braces should be fixed between the wall plate and the raker. Such braces can be placed either at right angles to the raker, or at right angles to the wall plate. Packing pieces should be inserted behind the wall plate to give the plate a continuous bearing throughout its length. Such packing should always be inserted where a wall is bulged either outwards or inwards. A needle piece drived through a hole cut in the correct position in the wall plate can be inserted in an air-brick opening in the wall, and this will effectively prevent the plate riding up the wall. Any projecting oversailing or string courses on the wall should also be used for a similar purpose provided they are high enough to obviate any undue shortening of the wall plate.

(b) **Flying Shore**

(i) **General** -A flying shore is used to support one wall from another and, as its name. implies, it derives no direct support from the ground. It can also be used between two buildings which are sound structurally but have been deprived of normal support by the removal of a building formerly between them. In rescue work the flying shore will normally be used so that a damaged building can be supported by an adjacent structurally sound building by bridging the gap between them with timbers, so framed and erected as to transfer the loads from the one to the other.



Dead shore

(ii) **Parts of Flying Shore** -The principal parts of a flying shore are the horizontal beam wall plates and struts or bracing pieces. Other parts used are straining pieces, wedges and cleats, all of which assist in securing the shoring in position and transferring the load.

(iii) **Method of Erection**-It is first essential to ascertain the distance between the two buildings in order that suitable shoring timbers can be selected from the debris available. This can be done without the use of measuring rods or tapes by utilising pieces of wood as distance pieces. The two pieces of wood are held together at the height at which the horizontal beam is to be placed and adjusted until their combined length registers the width between the walls. The measurement thus obtained is the transferred to the beam being assembled on the ground, due allowances being made e the thicknesses of wall plates and wedges. In a similar manner, pieces of lath can be used to measure the requisite length for the wall plate, remembering that this length should be sufficient to ensure that the weakened area of the wall is covered. If stout and straight enough, these measuring pieces will also indicate the amount of bulge in wall, and consequently the thickness of packing required behind the wall plate to ensure that it has a uniform bearing on the wall. Suitable timber should now be selected for the horizontal beams. As in the case of the rakers this can be made up of smaller section timbers such as joists, provided that they are well laminated and securely spiked together. The size of the finished beam will depend upon the width it is required span, and would vary from 6 in. x 4 in. to about 6 in. x 6 in for spans of 10 ft to 20 ft respectively. The laminated horizontal beam is made up, spiked together and cut to the length ascertaining by the measuring rods, after due allowance has been made for wedging and for the thicknesses of the wall plates selected. Sound timbers should be chosen and of matching sizes. At this stage the straining pieces should not be nailed to the horizontal beam, but temporarily secured to it, one above and the other below, by means of two wire bounds. This keeps the straining pieces in position during erection, and enables them to move as required during the wedging up process. Measuring rods should be used to mark the length of the wall plates. The width of the plate should not be less than the width of the beam, and its thickness should be sufficient to resist crushing by the beam when this is wedged into position. The wall plates should then be propped up at the correct distance apart on a cleared flat piece of ground, and the points where the beam and braces will be positioned marked with chalk, so that the cleats can be spiked in the appropriate places. A with the raking shores, the cleats should be of sound timber and of sufficient length to provide adequate fixing. Normally it is better to fix them with their grain and maximum dimension lengthways down the wall plates rather than across.

At this stage, any known requirements for packing pieces can be added, and if the packing is spiked to the back of the wall plate prepared for the damaged wall it will be possible to place the wall plate in its correct position more easily. With the cleats spiked in position and the horizontal beam in place, templates can be marked indicating the cuts to be made at the ends of the braces and their correct lengths The bracing pieces can now be made up using timbers to form braces of about 4 in. x 4 in. section e.g. two 4 in. x 2 in. joists of sufficient length. The cleats should have been fixed so that the braces will butt against then and against the straining pieces on the and against the straining pieces on the horizontal beam, and slope at the angle of 45 degrees between the beam and the wall plates. The angles cut at each end should also be at 45 degrees, and the ends should be cut squarely to make a good bearing. The complete flying shore can now be assembled on ground, and all points checked to ensure good fitting joints, or ample clearances where folding wedges are required for framing up purposes. When assembled thus, the dimensions should be carefully checked by means of the measuring rods to make certain that the whole structure will properly fit between the walls and can be wedged up securely so as to perform its function. Before moving any pieces on to the job, the parts should be clearly marked so that they can be re-assembled in their correct positions. The erection of the flying shore can now be commenced, and this is started by placing the appropriate wall plate against the damaged wall temporarily strutting or propping it in position, and inserting any temporary packing pieces needed. In many cases the damaged wall may be unsafe and should not be used to support ladders unit at least some support has been given to it by the shoring. A strut can be fixed to provide temporary support to the wall plate. This strut is lodged under the middle cleat which will carry the horizontal beam. Care should be taken not to subject the damaged wall to undue jarring or shock. The wall plate on the damaged wall having been positioned, the other plate can be temporarily fixed in a similar manner, taking care to ensure that the tops of the two middle cleats are levelled with each other, so that the beam will be horizontal when it rests upon them. The horizontal beam can now be raised into position by placing one end on one w plate and carefully joisting the other end. To assist in the boasting of the horizontal beam ladder or ladders can be used against the undamaged wall, and a rope used in aid in the lifting This operation must be done with great care and the wall plates, (particularly the bearing of the beam on the first wall plate) must be closely watched. Folding wedges a drived in at the end of the horizontal beam by the sound wall to tighten the beam securely against the wall plate on the damaged wall, so that any load exerted by the tendency of the wall further to move or bulge will be transferred by the beam to the strong supporting wall and thereby resisted. Having received some support, the damaged wall can be expected withstand the weight of a short ladder, and the flying shore may be completed by the insertion of the four diagonal braces. The lower pair should be fixed first and be a tight fit between the straining piece and the bottom cleats, but it must be wedged if necessary. The upper pair of braces should be fixed and wedged tightly into position with folding wedge at each end of the straining piece. The shore is now firm enough to support ladders and erectors. The flying shore is completed by tightening up the folding wedges and inserting any necessary packing pieces to ensure that the wall plate at the bulging wall has an even and continuous bearing throughout its length. The straining pieces should now be spiked to the horizontal beam and the wire bonds removed. It is not advisable to erect a flying shore between two walls which are more than 25 feet apart. Additional flying shores should be placed along the wall requiring support, at intervals of 8 ft to 12 ft depending upon the circumstances and degree of damage.

(c) **Dead/Vertical Shore**

(i) **General**-A dead shore carried the vertical load of a wall or floor. The dead shores set as stanchions and should be as short and as stout as possible. They must always be placed on a firm support and, where different levels are encountered, shores must be carried down until they can obtain adequate support.

(ii) **Parts of Dead Shore**- The principal parts of a dead shore are the sole-place, the dead shores and the head plate. Other items are braces-to tie two or three shores together, and folding wedges.

(iii) **Methods of Erection**- The sole piece is laid down in position taking care that it is placed on a solid foundation. The head-piece is held in position and the vertical or dead shores are then placed upright between the dead shore and the sole-piece. These wedges should be tightened simultaneously. In using folding wedges care should be taken that the wedges are married" before tightening is attempted. ("married" means that one point overlaps the other after insertion of the wedges). Where braces are necessary, they should be long enough to extend diagonally from the head-piece across the shore to the sole-piece and nailed to each in turn. It must be remembered that vertical or dead shores may be carrying the full weight of the structure above whereas raking and flying shores mainly oppose to overturning tendency. It is very important, therefore, to have a solid bearing for the sole-piece. The sole-piece must be as broad and as long as possible in order to spread the load. It is fairly difficult to estimate what load a vertical or dead shore will carry but the following rules may help:

(aa) The shorter the length, the greater the load it will carry.
(ab) The strength is increased if the ends are cut square to fit on the head and sole piece.

18. **Safety Precautions during Shoring** -The following safety precautions should be followed to avoid damage to structures and rescuers:

(a) Do not try to force a wall or beam back into its original position.

(b) Use levering and wedges or cleats to tighten the rakers or struts.

(c) Hammering of cleats should be done before the wall plates are erected.

(d) While raising or supporting beams or sections of floors ensure that the stability of the rest of the building is not disturbed.

(e) Ensure all raised sections are firmly supported by struts or cribbing before allowing any one to crawl underneath it.

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CHAPTER 13

CASUALTY HANDLING IN RESCUE OPERATIONS

1. **Introduction**-All seriously used casualties will require transportation from the point wherefrom to the forward medical aid unit. There is nothing better on which to convey a badly improvise one rather than man handling the casualty. Finally, situations may arise wherein the injured casualty than a stretcher. However, when there is shortage of stretchers it would be better to rescuers would have to use emergency methods involving their bare hands and feet. In order to make the casualty comfortable the technique of blanketing a casualty must be mastered.

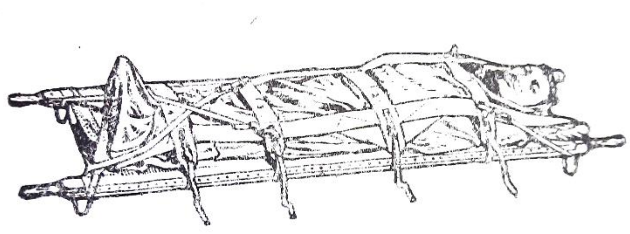
STRETCHER HARNESS. LASHING AND SECURING OF CASUALTIES

2. **General**-When casualties are required to be removed on stretchers from confined places, high buildings, through narrow passages, over rough ground or with lesser bearers, it becomes necessary to adopt additional measures to ensure safety of the casualty during its removal on stretcher as well as making it convenient for the bearers. Use of stretcher harness and lashing the stretchers are two important measures that can be adopted for such purposes. All members of the Rescue Parties and First-aid Parties must be fully conversant with the use of these.

3. **Stretcher harness**-During rescue operations there is a possibility of the bearers stumbling and of the debris moving, with a consequent risk of the casualty being thrown off the stretcher. In some instances, the stretcher will have to be turned on to one side, or up-ended, to pass some obstruction, and on these occasions, it is necessary for the casualty to be securely fastened to the stretcher. This is done either by using the manifold stretcher harness or by improvising with a 40 ft. lashing line. There is a recognised drill for the application of the "Manifold" Stretcher Harness as follows. (Two bearers are required to adjust the harness).

(a) Casualty is laid on the prepared stretcher.

(b) (i) No. 1 places the harness (see Fig) on the casualty so that the widened part covers the trunk, with cross strap marked "1" one hand's breath below the chin. No. 2 assists No. 1 and bunches the free ends of the transverse straps at the side of the stretcher.



Application of manifold stretcher harness

(ii) (For casualties of Abnormally Small Size-Five feet four inches and under.) The harness is placed on the casualty with the wide part covering the trunk, and No. 1 threads the casualty's head through the top window and pulls it down so that the cross marked "1" fits snugly behind the neck. No. 2 assists No. 1 and bunches the free ends of the transverse straps at the side of the stretcher.

(c) Nos and 2 lift the stretcher to knee level and move it to the side until the transverse straps protrude on the buckle side.

(d) No. now passes the upper longitudinal head straps OVER the top of the stretcher, UNDER the handle, THROUGH the runner and makes secure by fastening to the buckle on its own tide on the cross strap marked "1".

(e) At the same time No. 2 is loosely bucking off the four transverse straps, working from the head to the feet.

(f) (i) Both bearers now adjust the feet straps by crossing them below the soles of the boots, p them OVER the side of the stretcher. BACK through the runner, up OVER the lower edge of the stretcher canvas crossing them diagonally over the patient's legs and fastening them opposite buckle on the cross strap marked "3".

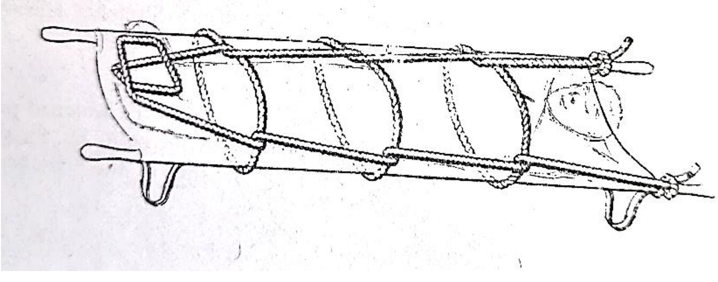
(ii) (For Casualties of Large Size-Six Fees and Over) Both bearers adjust the feat steagy by passing them below the soles of the boots, BACK over the insteps OVER the side of the stretcher, BACK through the runner OVER the bottom edge of the stretcher canvas and fastening them off to the buckles on the same side, or the opposite side if length of straps permit.

(e) Nos. 1 and 2 then tighten up all straps working from feet to head.

(h) The stretcher is then tilted to test for security, and all buckles inspected to insure that there is no loosening.

4 **Improvised stretcher harness**

(a) **Securing**-In the improvised method with the 40 ft lashing line, the only knot used is the slow hitch, which is as simple to tie in the darkness as in daylight, and which will never fail It is formed by making two loops in the rope, both anticlockwise, the second loop, which tends come in front, being placed behind the first. It can also be formed by making a loop on the handle of the stretcher, so that the running end is imprisoned by the standing part, followed by another loop Form the first knot on a handle near the head of the casualty, pass the rope down the side of the stretcher, taking a complete turn under the stretcher and back over the casualty’s chest, forming a half hitch. At least three turns must be used, two above the knees and one below. The rope is then passed round the casualty's feet brought up on the opposite side stretcher and fastened with a clove hitch. (See Fig) Care should be taken to prevent the turns and the half hitches of the lashing from pressing on injuries to the casualty.



Improvised harness by lashing

(b) **Releasing the casualty**-To release the casualty quickly from the stretcher, two men, one on either side of the stretcher remove the clove-hitches from the stretcher handles. Working in unison, they proceed towards the casualty's feet, gently releasing by a slight pull on the lashing the turns around the casualty. They then remove the turn around the feet and release the lashing from under the stretcher.

(c) **Precautions**

(i) The lashing should not be secured so tightly around the casualty as to hurt the injured part or to interfere with the breathing.

(ii) The hitch around the feet and ankle must be sufficiently tight to hold the casualty firmly when the stretcher is held up vertically.

5. **Improvisation of stretcher carriage**-If proper canvas stretcher harness is not available this can be improvised as follows:

(a) Using pieces of ropes with 'spliced eyes' or bowlines' to provide loops for slipping over the handles of the stretcher. This can be done as under:-

(i) **Spliced Eyes-**Serviceable pieces taken out of 40-1 ½" (12.10 M-38mm) lashing rope, sufficient to be worn by the stretcher bearer across his chest from one shoulder to the other side with both ends of the rope spliced before-hand to provide two loops for slipping over the handles of the stretcher. A pair of this is required by each of the two bearers.

(ii) **Bowlines**-In place of 'spliced eyes, as described above, bowline knots can be made as the ends of ropes, on the spot, to provide similar loops for securing to the handles of the stretcher.

(b) **Using triangular bandages**-A few triangular bandages joined together can be used likewise for securing to the stretcher handles by using clove hitches and worn by the stretcher bearers.

BLANKETING OF CASUALTIES

6. In all cases of serious injuries "shock" is likely to develop. Rest, fluids and warmth are useful measures for prevention of the same. Warmth can be given with help of blankets and hot water bottles. It must be remembered, however, that in hot humid climate, the application of too much of warmth will cause the patient to sweat and make his condition of shock worse One, two or three blankets can be used with a patient. It is worth while to know how to make best use of the blankets available to provide maximum amount of warmth.

(a) **One Blanket method**

(i) Place the blanket diagonally on the stretcher .

(ii) Place the patient on the blanket

(iii) Fold over the leg end of the blanket tucking it between feet.

(iv) Wrap the two sides over the patient, the right side first and tuck in.

(v) Wrap the head end of the blanket round the neck of the patient and secure the neck of the patient and secure the end in-front with a safety pin.

(b) **Two-blanket method**

(i) Place the first blanket breadth-wise across the top of the stretcher.

(ii) Fold the second blanket length-wise into three and place it on the first blanket folding back the corners at the lower end.

(iii) Place the patient on the stretcher.

(iv) Wrap the opened-out portion of the second blanket over the patient's feet, first the lower end and then the right and left flaps, tucking them in.

(v) Wrap the end of the first blanket over the patient, at the same time turning back the upper corner to form a coat collar over the chest.

(c) **Three-blanket method**

(i) Prepare the stretcher as for two blanket method.

(ii) Fold the third blanket length-wise in to two equal folds and place it over the patient, before the other two blankets are folded back. Thirty ems. over the chest and the lower end tugged in under the feet.

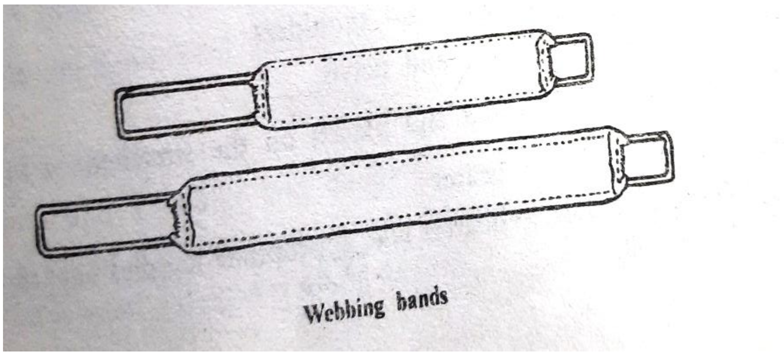
CARRIAGE OF CASUALTIES

7. A casualty may be loaded on to a stretcher or may be carried for a short distance by means of webbing bands, blanket lift or by bearer themselves without the use of equipment. These drills are explained in subsequent paras .

8. Webbing bands.-Sets of webbing bands are carried by rescue parties and are used for

Lifting a patient from the ground on to a stretcher, or

Lifting and carrying a casualty from a place where it is impossible to use a stretcher. Each set consists of four bands made of stout canvas webbing 4½ inches wide and of two different lengths, two being 2 feet long and two 3 feet long. The shorter bands are intended to go under the head or neck and the feet, and the longer ones under the chest and hips (or small of the back). Each band has a long handle at one end and a short handle at the other. The handles are made of ¼ inch drawn steel wire welded at the joint, the long handle being 12 inches long and the short 4 inches. The long handles are used for pushing under the body of a casualty lying on the ground, after which the webbing band is pulled through so that there is a handle at each side.



Some of the advantages of webbing bands are:-

(a) Comfort for the casualty.
(b) Little effort for the bearers.
(c) Speed if necessary.
(d) Slow movement if advisable.
(e) Heavy casualties can be lifted with ease.
(f) A casualty can he turned over.
(g) No undue pressure need be put on any injured part.

9. To insert a band the bearer grasps the long handle with his right hand at the point where the handle joins the canvas and, slightly raising the casualty with his left hand, he pushes the hand under him. The bearer on the other side raises the casualty slightly with his left hand and pulls the handle and band through with his right hand. The casualty need be raised only a quarter of as inch i.e. the thickness of the metal handles. When a casualty is lying close to a wall or other obstruction is not possible to pull the long handle and pushed through by it; the short handle is then pulled through and the long handle withdrawn simultaneously. To turn a casualty from the prone to the supine position, or vice versa, the bearers proceed as for a normal lift but ensure that the four handles on one side are close to the body. The bearers then lift the casualty off the ground with the handles one side low and on the other side high, the low handles are raised and the high handles lowered and by this movement the casualty is gently turned over. The drills for the normal lift, the heavy lit and the wall lift, using webbing bands, are described below:

(a) **The normal lift**

(i) **Position of bands**

(aa) Short band under head (supporting band only).
(ab) Long band under shoulders.
(ac) Long band under pelvis.
(ad) Short band under calves.

(ii) **Inserting of bands**

(aa) **First Stage**

No. 1 hearer to left of casualty at shoulder with long band pushes through.
No. 2 bearer to right of casualty pulls above band through.
No. 3 bearer to left of casualty at calves with short band pushes through.
No. 4 bearer to right of casualty pulls above band through.

(ab) **Second Stage**

No. 1 bearer pushes short band under head.
No. 2 bearer pulls short band under head.
No. 3 bearer pushes long band under pelvis. No. 4 bearer pulls long band under pelvis.
NOTE: All band in this lift must be centralised in order to get a level lift.

(iii) **Position of bearers**
No. 1 and No. 2 take head and shoulders.
No. 3 and No. 4 take feet and pelvis.

(iv) **The casualty is now raised and placed on the stretcher**.

(aa) Orden-by No. 1 bearer
(ab) "Prepare to Lift".-Bearers take appropriate handles in each hand, standing clos to casualty.
(ac) "Lift".-Bearers lift together and take a short pace forward, close up to the casualty to prevent his swaying .

(v) **The stretcher is now loaded**.

Inserting hands

(b) **The heavy lift-** For lifting very heavy casualties where five bearers are available.

(i) **Position of bands**
(aa) Long band under shoulders.
(ab) Long band under small of back.
(ac) Short band under thighs.
(ad) Short band under calves.

(ii) **Inserting of bands**

(aa) **First Stage**
No. 1 bearer to left of casualty at shoulders with long band, through. pushes
No. 2 bearer to right of casualty, pulls above band through.
No. 3 bearer to left of casualty at calves with short band, pushes through.
No. 4 bearer to right of casualty, pulls above band through.

(ab) **Second Stage**

No. 1 bearer at small of back, with long band, pushes through.
No. 2 bearer pulls above band through.

(ac) **Third Stage**

No. 3 bearer at thighs with short band, pushes through.
No. 4 bearer pulls above band through. The bands are centralised, unless the casualty needs turning and dropped to the ground.

(iv) **Position of bearers**

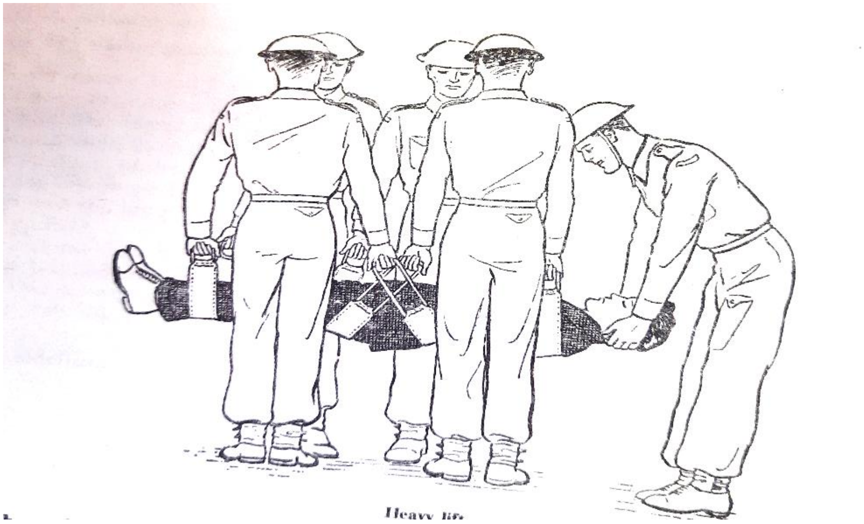
(aa) Nos. 1 and 2 bearers take bands (a) and (c).
(ab) Nos. 3 and 4 bearers take bands (b) and (d).

NOTE: Another beater is co-opted to support the head.

(v) The casualty is now raised and placed on the stretcher

(aa) Orders-As in the normal lift.

NOTE:- This method may be adopted for moving a spinal casualty in which case the bearer at the head maintain gentle traction (on the head). Where it in certain, or suspected, that the fracture is in the lumber region, a sixth fully trained bearer is necessary to apply grade traction to the feet and legs, while the fifth bearer supports but does not maintain traction the head.



Heavy lift

(c) **The wall lift**

(i) **Position of bands-**Three only as in the normal lift.

(ii) Inserting of bands

(aa) **1st Stage**

No. 1 bearer at shoulders, long band pushes through.
No. 2 bearer at shoulders, assists and pulls through.
No. 3 bearer at calves, short band, pushes through
No. 4 bearer at calves. assists and pulls through.

(ab) **2nd Stage**

No. 3 bearer at pelvis, long hand, pushes through.
No. 4 bearer at pelvis, assists and pulls through.

(ac) Bands are centralised unless the casualty needs turning.

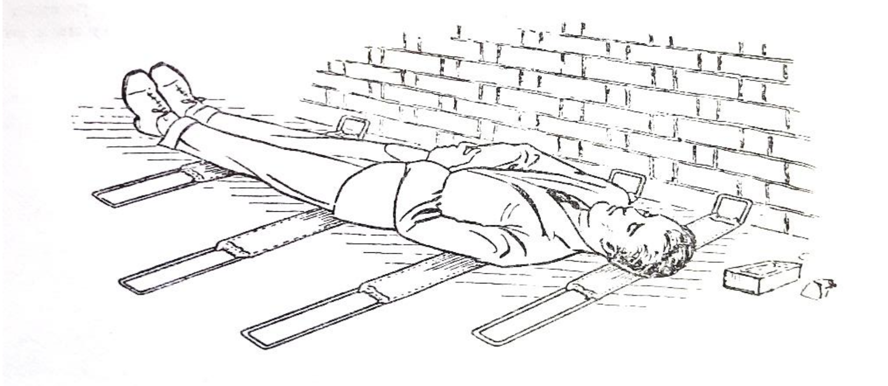
(iii) **Position of bearers**

(aa) No. 1 bearer supports the head.
(ab) No. 2 hearer at shoulders.
(ac) No. 3 bearer at pelvis
(ad) No. 4 bearer at feet facing head of casualty.

(iv) When the appropriate orders have been given each bearer takes up the handles of the band in front of him the casualty is raised and may be turned, or moved, as required.

Note:- The normal lift may be reverted to-and casualty placed on the stretcher.

Wall lift—inserting of bands



Bands in position

EMERGENCY METHODS

10. When casualties are in danger of receiving further injuries, it is necessary to remove the cause of danger from the casualty or the casualty from danger. If it is vital to remove the casualty to safety, he must be moved regardless of his injuries. Only when the casualty is in imminent danger of death by remaining where he is, does removal take priority over the stoppage of bleeding. Some of the methods of removing casualties are mentioned in subsequent paras.

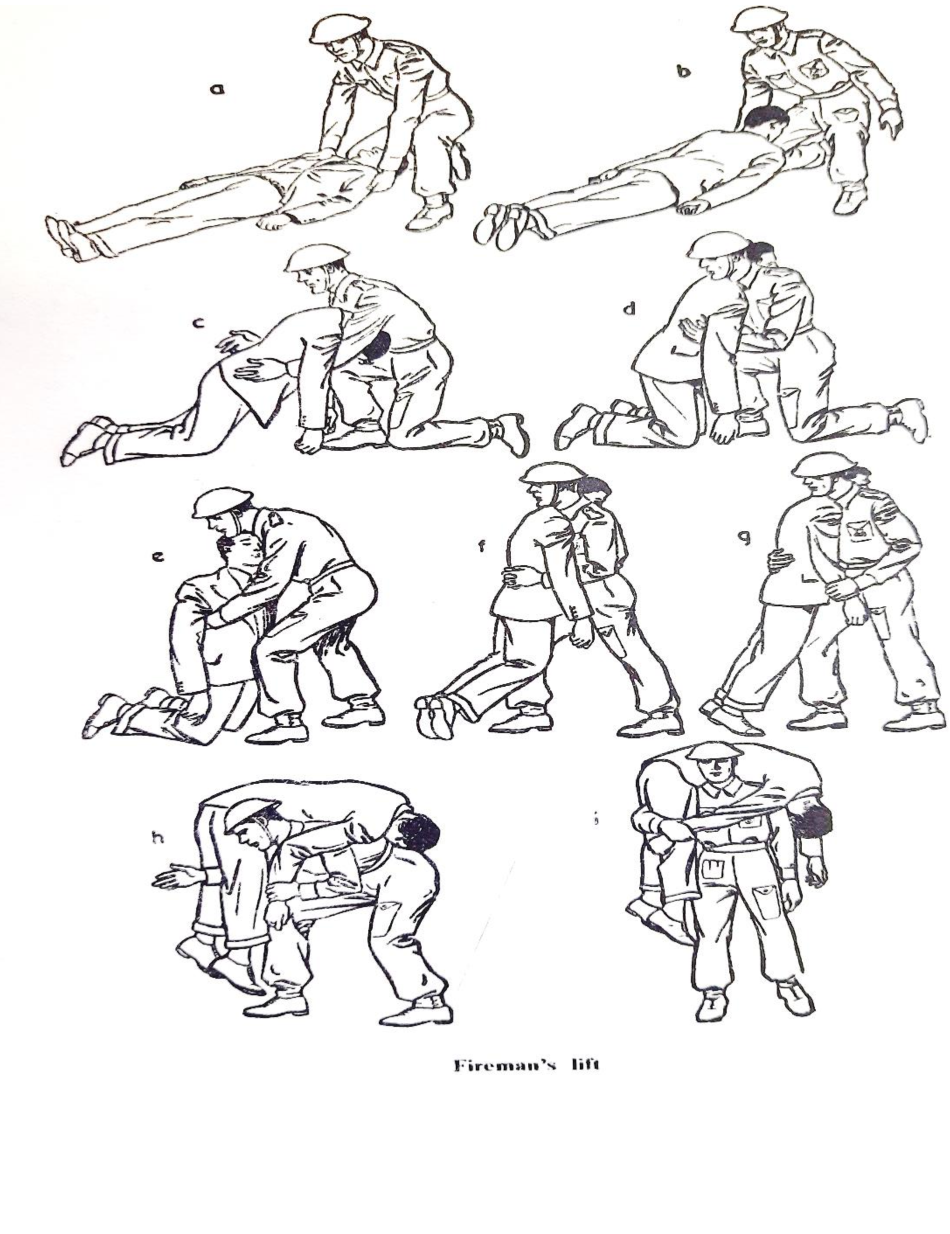
(a) **Hand carriage**

(i) **Pick-a-back**-Carry the casualty in the ordinary pick-s-back position. This is the he way if he is conscious and able to hold on.

(ii) **Human crutch**-Where the casualty can help himself the rescuer stands at his injured side and places the casualty's arm round his shoulder grasping the wrist with his hand, At the same time he passes his other hand round the casualty's waist gripping his clothing at the hip, and thus assists him by acting as a crutch. Each person should step off with the outside foot-the rescuer using his nearest to the casualty as a prop-as in a three-legged race.

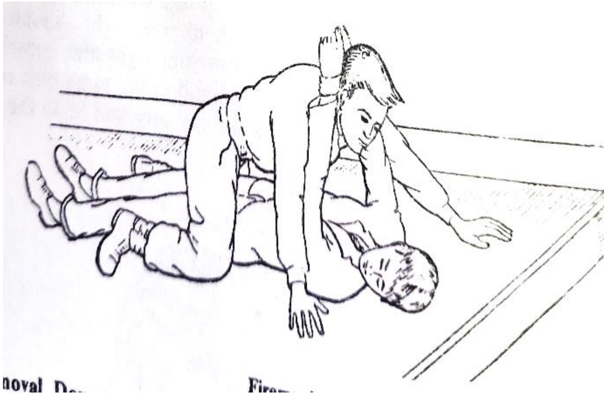
Human crutch

(iii) **Fireman's lift**- This is one way of carrying a helpless or unconscious patient and allows the rescuer a free hand. It is easier for the rescuer than pick-a-back, but not so comfortable for the patient. Various stages of the lift are shown in Figure below. If the casualty is lying on his back, kneel on one knee (usually the right) at his head, place your right hand upon his right shoulder, and with your left hand beneath his left shoulder turn him over gently on to his face so that his forehead and face are supported on your right forearm. Place your hands beneath the casualty's shoulders and lift him up to a kneeling position, supporting him against your body with his head on your right shoulder. With your hands in the casualty's armpits stand up and lift him on to his feet, pressing the body close to yours; shift your hands from his armpits and clasp them together round his waist. Keep your right arm round the casualty's waist and grasp his right wrist with your left hand carrying the limb away from the body. Stoop and place your hand beneath his right arm and hoist him up on to your right shoulder. still retaining hold of his right wrist with your left hand. Pass your right arm between the casualty's thighs and grip his right wrist with your right hand at the same time remove your left hand which becomes free. Shift the weight of the casualty well on to the centre of your back and rise to the erect position.



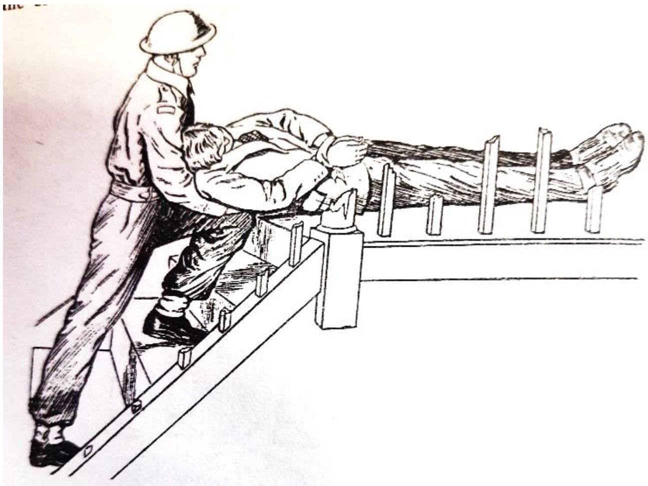
Fireman's lift

(iv) **Fireman's crawl-** If a rescuer finds an unconscious casualty, or one who is unable to help himself, or who is too heavy for one of the above three methods to be applied, the Fireman's Crawl can be used. Turn the casualty on to his back and tie his wrists together. Kneel astride him facing his head and place your head through the loop thus formed by his arms. By crawling on your hands and knees you can then drag him with you, even though he may be heavier than you are.



Fireman's crawl

(v) **Removal Downstairs-**To move the casualty downstairs, lay him on his back, head downwards on the stairs, place your hands under his armpits so that his head rests on the crook of your arm and ease him gently downstairs.



Removal downstairs

(vi) **Bowline Drag**

(aa) Turn the casualty on his back and tie his wrists together using a triangular bandage or a neck-tie.

(ab) Using one length of 15 feet (4.5 M) sash cord or 40 ft (12 M) lashing, the bowline at each end to form the loops.

(ac) Place one loop over the casualty's chest and under his armpits, with the knot resting under his head, so that it will keep his head off the ground while he being pulled (ad) The other loop goes on the rescuer, over his shoulders and under his armpits, to form a harness with the knot in line with the centre of his back or between his shoulders.

(ae) The rescuer crawls on his hands and knees and drags the casualty out.

(vii) **Toe Drag**

(aa) Turn the casualty on his back and tie his wrist together using a triangular bandage or a neck-tie.

(ab) The rescuer sits down at the casualty's head and places his feet under the casualty's armpits.

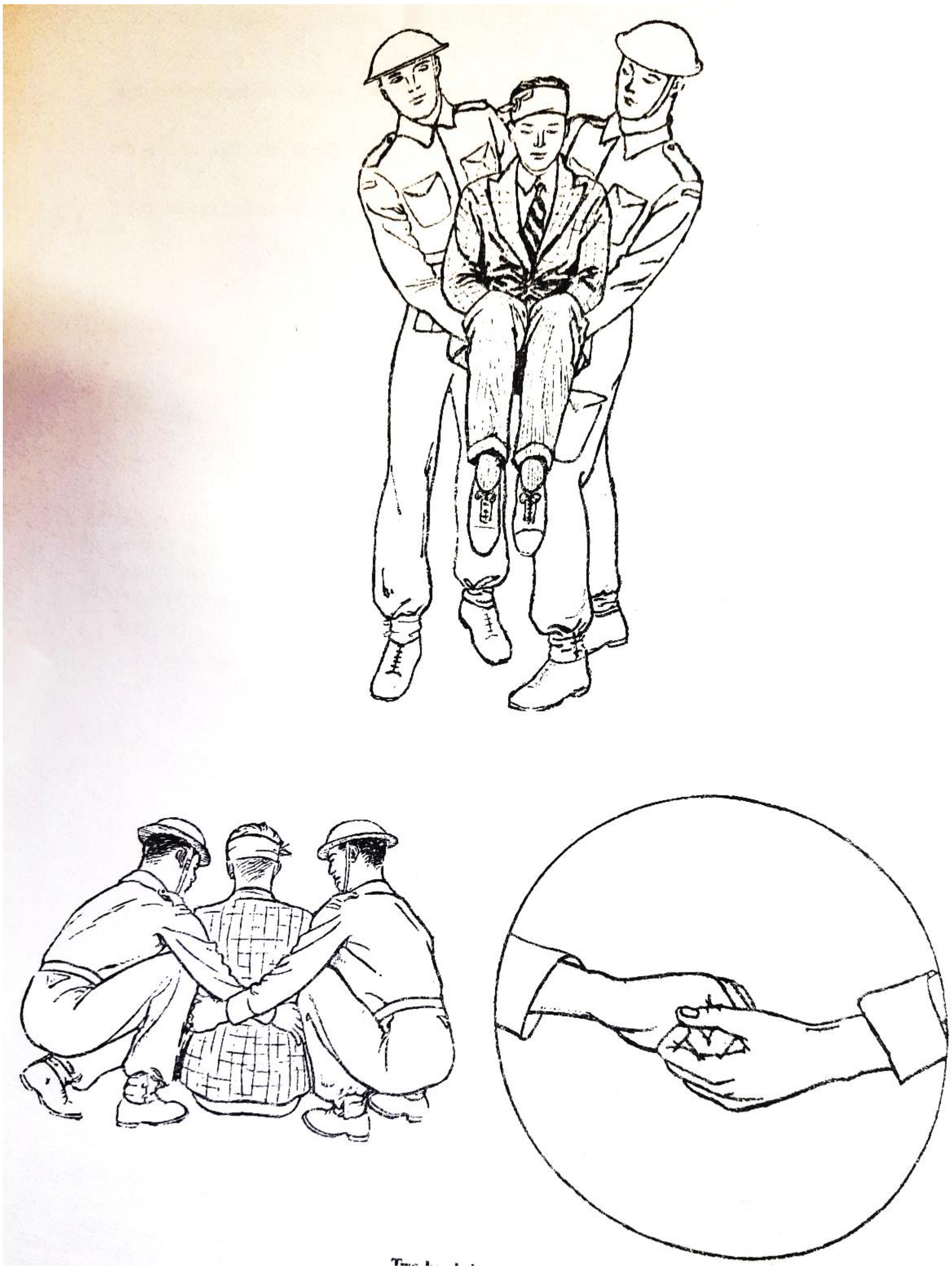
(ac) With both hands free the rescuer pulls himself back and at the same time drags the casualty with his fee.

Blowing Drag

(viii) **The Fore and Aft Method**-The patient is placed on his back. One rescuer raises the shoulders and passes his hands under the arms from behind clasping them in front of the chest. The other rescuer takes one leg under each arm and they carry him feet first. If the leg is broken, both legs should be tied together, or put in splints and both carried under one arm.

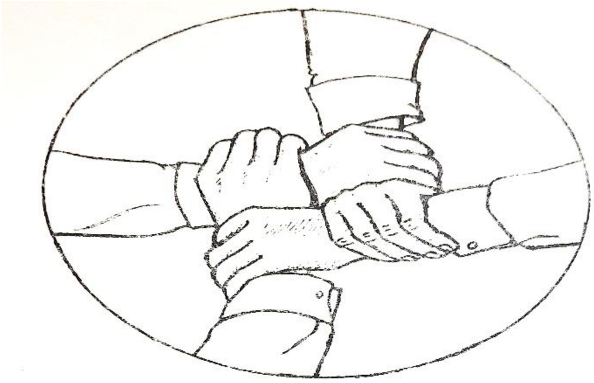
Four and aft method

(ix) **Two Handed Seat**-Two rescuers face one another on either side of the casualty and stoop. Each rescuer passes his arm nearest the casualty's head under his back just below the shoulders and, if possible, grips his clothing. They raise the casualty's back and slip their other arms under the middle of his thighs, clasping their hands with a hook grip. The rescuers rise together and step off with short paces.



Two handed seat

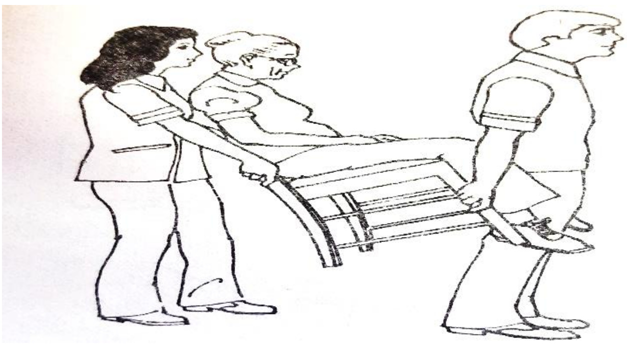
(x) **Four Handed Seat** -The rescuers face each other and each grasp their own left wrist with their right hand. Their hands are then put together, the free left hand grasping the right wrist of the man opposite. The casualty puts one arm or both arms round the necks of the rescuers.



Four handed seat

(xi) **Chair Carry**-The Chair carry is effective where sharp turns or a steep straight would preclude the use of a stretcher or backboard. A commercial stair chair or an ordinary household straight-back chair may be used is a good idea to test the chair before use to make sure that it is solid and will support the patient.

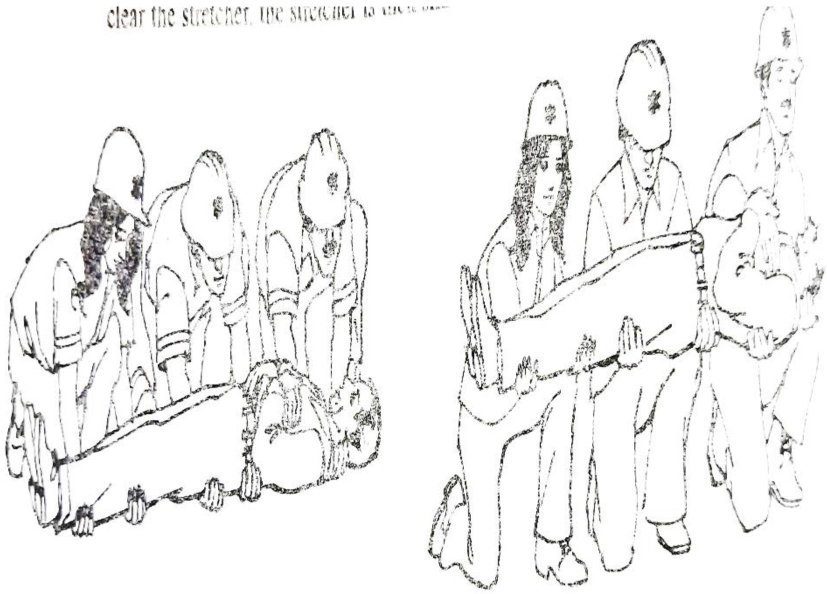
After the victim has been placed in the chair, the rear paramedic tilts the chair back to enable the other crew members in front to get into position. If the victim is too large to be picked up and placed in the chair, then the person is placed face up. The legs are elevated and the chair back slid beneath the buttocks until the patient is in a seated position, although still lying on the floor. Straps may be used to secure the patient to the chair. The chair is then tilted upright and the victim is ready for transport.



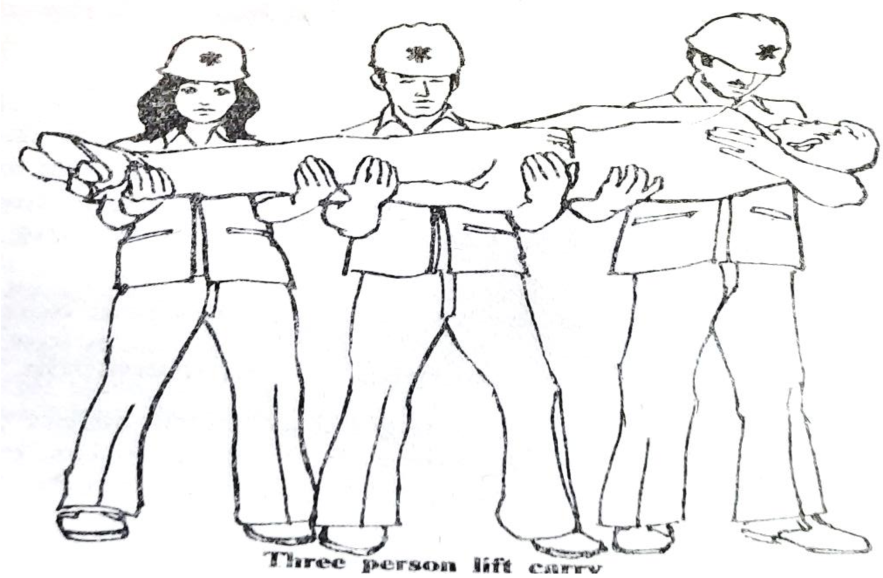
chair carry

(xii) **Three-Person Lift and Carry**- The three-person lift and carry is often used to handle a severely injured casualty. Even with trained personnel, this technique does not offer adequate neck and back support. When there is any suspicion that spiral injuries may be present, a fourth paramedic should support the patient's head. Three rescuers line up on one side of the casualty, preferably with the tallest person at the shoulders, another at the hips, and the third at the knees. The team kneels on their knees nearest to the victim's feet. The paramedic at the victim's shoulders works both hands under the victim's neck and shoulders, the person at the hips places both hands under the pelvis and the hips and the EMT at the knees responsible for lifting the knees and ankles. At the command lift, usually given by the rescuer at the shoulders, the crew gently lifts and rests the victim on their knees. At a second command, they slowly turn the victim towards them until the casualty rests in the bends of their elbows. At a third command, the crew rises together to a standing position.

When a stretcher is not immediately available, these procedures allow the crew to move with the patient through narrow spaces and down winding stairs. Depositing the victim requires the reverse of this procedure. These steps are also recommended for picking up and placing a victim on a stretcher or cot. The casualty is raised only high enough to clear the stretcher, the stretcher is then slid under the victim, and the victim is lowered.



Three person lift carry



Three person lift carry

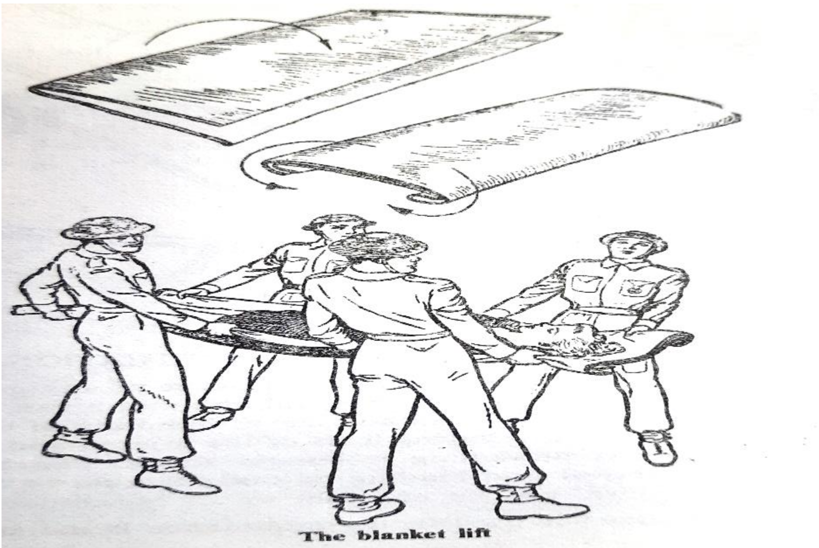
(xiii) **Clothes Lift**

(aa) Normally four bearers are required for this lift. Two bearers kneel on each side of the casualty at the shoulders and hips and turn him on his back.

(ab) At the command 'Prepare to Lift. the bearers grasp the casualty's clothing. Those at the shoulders will graps the collar of his coat or shirts behind the neck with one hand and with the other grasp the clothing at his side.

(ac) The bearers at his hips will grasp the clothing at the hips with one hand, and at the same time they will insert one finger in his sleeves in order to control the casualty's arms. With the other hand they grasp the casualty's trousers, thus supporting his legs The casualty is now ready to be lifted.

(xiv) **Blanket Lift**



(aa) A blanket is placed lengthwise on the ground in line with the casualty and rolled up width.

(ab) The casualty is then carefully turned on his side.

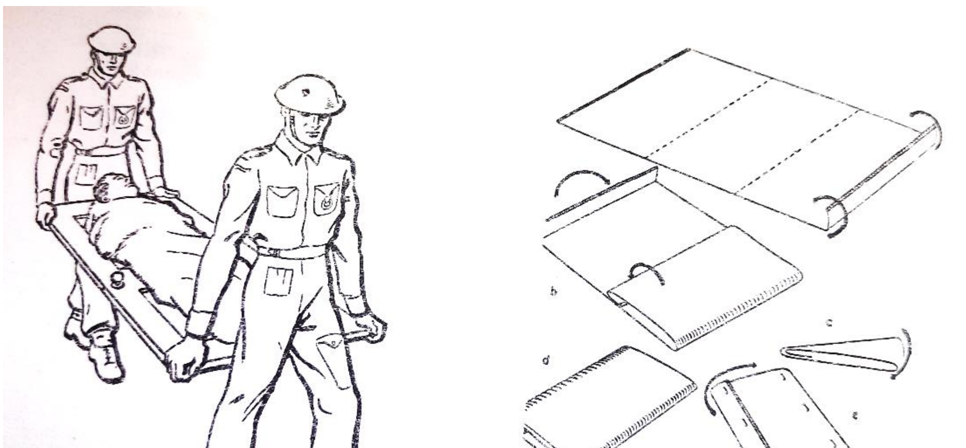
(ac) The rolled-up portion of the blanket is then placed close to the casualty and he is gently replaced on his back upon the unrolled portion of the blanket.

(ad) The rolled portion is then unrolled so that he lies in the centre of the blanker.

(ae) The two edges of the blanket are then rolled up against the casualty's body, grasped by two bearers on each side of the casualty, thus supporting the head, shoulders legs and hips.

(b) **Improvised stretchers**-When there is a shortage of stretchers it is better to improvise rather than manhandle the casualty unnecessarily. An old door (see fig below), a sheet of galvanised iron, a blanket, or a short ladder are all examples of improvisation.

Another method is to fold a blanket into three, using six of eight safety pins (three or four on each side) to pin the edges of the blanket together Two small poles, broom handles etc, are passed through the folds and the improvised stretcher is ready for use. Refer sketch below.



Another from of improvised stretcher

HANDLING STRETCHERS IN VARIOUS SITUATIONS

11. **Stretcher drill**-An injured person is normally apprehensive of any movement of his body especially the wounded part. A well-trained squad of first-aid volunteers can, however, reduce the degree of apprehension by their confident yet careful and clever handling of the limb or body and gain the trust and co-operation of the injured. Allaying fears of the injured and reducing movements to minimum, help considerably towards preventing traumatic shock. The knowledge of correct methods of handling of stretchers, removal and loading of casualties on to stretchers and use of blankets and hot water bottles, therefore, will be an asset to all concerned.

12. The most common type of stretcher used in the ambulance is the stretcher with wooden poles and canvas material for holding the patient. Certain figures may be of interest and practical value to all. These are:

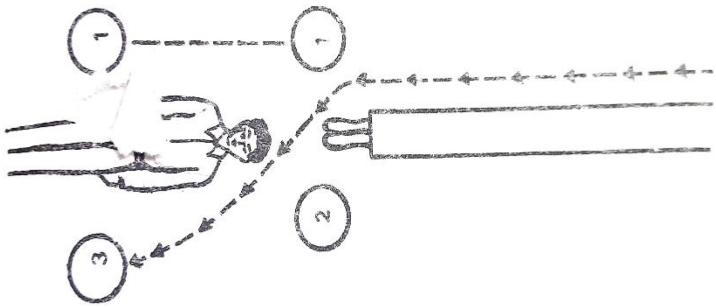
Length of pole	7 ft 9 inch (230 cm)
Length of Canvas	6. (180 cm)
Total width	1 ft 11 inch (57 cms)
Height above ground	0 ft. 6 inch. (15 cm)
Weight	30 lbs. to 32 lbs (14 kgs.)

(a) **Selection and numbering of bearers**-Four bearers will be selected and numbered 1, 2, 3, 4 from tallest to shortest in order to give as even to carry as possible. They will take up the position shown in figure below. No. 1 bearer is the leader of the squad and is responsible for the welfare of the casualty until he is seen by a Doctor or handed over to another responsible person. All stretcher bearers must be able to undertake the duties of No. 1 bearer.

(b) **Collection of blankets and stretchers**-No. 1 will give the command, No. 3 collect Blankets No. 4 collect stretcher "right turn-quick march". The named bearers will collect the blankets and stretchers. No. 3 will fold the blankets neatly and carry them over his right arm and No. 4 will carry the stretcher at the slope on the right shoulder runners to the front. On their return No. 3 will resume his position behind No. 1 and No. 4 will slide the stretcher foot first between Nos. 1 and 2 runners to the right and resume his position behind No. 2.

(c) **Lifting stretcher**-On the command "Lift Stretcher". No. 2 and 4 stoop together, grasp the handles of the stretcher with their right hands, knuckles to the right, and rise together.

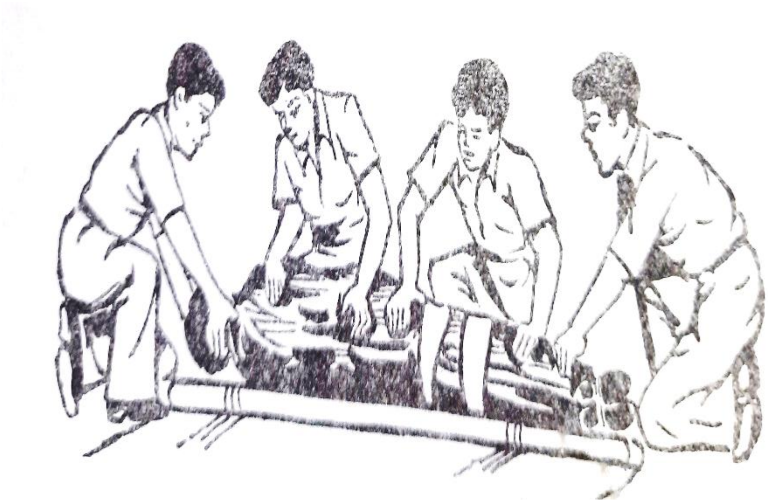
(d) **Collecting casualty**-On the command "At the Double-Collect casualty", the squad will double to the casualty and halt when the leading bearers are a short distance from the head Nos. 2 and 4 will lower the stretcher and place it on the ground in line with the casualty. No. 1 will then double out to the right of the casualty and prepare him for removal. He may Instruct No. 3 to assist him.



(e) **Loading stretcher.**

(i) **Casualty lying on blanket/rug-**When the casualty is lying on a blanket or rug the edges of the blanket or rug must be firmly fooled close up to the casualty. On the command "Load Stretcher", the bearers, two on either side, will grasp the rolls and, unless a fifth bearer is available to slide the stretcher underneath the casualty, will move by side paces over the stretcher and lower the casualty carefully on to it. This is known as the blanket lift.

(ii) **Casualty not lying on blanket/rug-**When the casualty is not lying on a blanket or rug and a spare one is available the casualty must be placed on a blanket or rug. place the blanket or rug on the ground alongside the casualty and roll it lengthwise for half its width. No. 2, 3, and 4 will turn the casualty carefully on to his uninjured side. No. 4 will place the rolled portion of the blanket or rug close to the casualty's back and all the bearers will gently roll the casualty over until he is lying on his opposite side on the blanket or rug. The blanket or rug will then be unrolled and the casualty gently turned on his back so that he lies in the centre of the open blanket or rug. On command "Load Stretcher" proceed as at 12 (e) (1) provided four or more bearers are available, the blanket lift or rug lift is the best method for loading a casualty on to a stretcher owing to the smoothness of the whole operation.

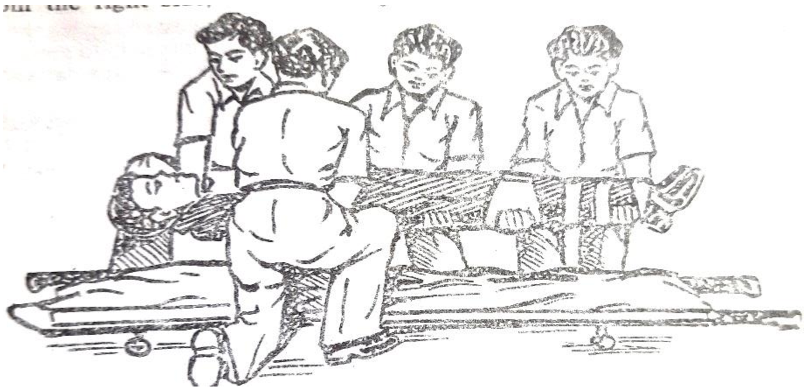


(iii) **Casualty not lying on blanket and blanket not available**-When the casualty is not lying on a blanket or rug and none is available, on the command "Load Stretcher" Nos. 4, 3 and 2

will place themselves on the left of the casualty, No. 4 facing the shoulders, No. 3 facing the hips and No. 2 facing the knees: No. I will place himself on the right of the casualty facing No. 3. All will go down on their left knees and place their forearms beneath the casualty. paying particular attention to the site of the injury. Using the hook grip No. joins his left hand with the left hand of No. 4 and right hand with the right hand of No. 3 and 4 supports the head and shoulders, No. 2 the lower limbs.

When No. 1 gives the order "Lift" the casualty is lifted gently and slowly and placed on the knees of Nos. 4. 3 and 2. No. 1 will disengage, take hold of the stretcher (left hand across, resting the near pole on his left hip) and place the stretcher under the casualty, so that

when he is lowered on to it his head will just be clear of the metal bar at the top and will rest on the pillow if one is available. No. 1 will then resume the position. When No. 1 gives the order "Lower", the casualty will be raised slightly from the knees of Nos. 4, 3 and 2, lowered gently and carefully on the stretcher and covered with coats. The bearers then rise and turn to face the foot of the stretcher, if it is necessary to lift the casualty from the right side, bearers will go down on their right knees.



(f) **Standing to stretcher**-On the command "Stand to Stretcher", No. I will take up a position level with the handles at the foot of the stretcher: No. 2 will step forward opposite No. 1 and No. 3 will double and the head of the stress her opposite No. 4. When standing to stretcher the positions of Nos 1 and 3 bearers will be on the right and those of Nos. 2 and 4 on the let of the stretcher.

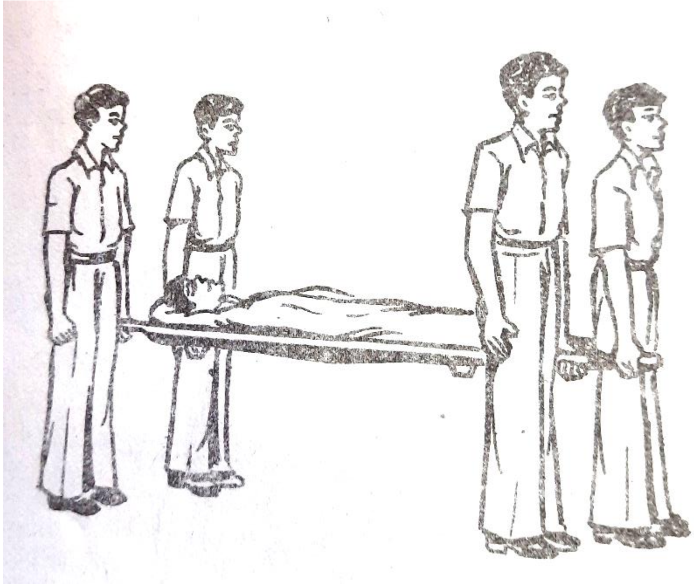
(g) **Carrying loaded stretcher**-No. I will decide whether the stretcher is to be carried by Sour or two bearers. The drill will be as under: -

(i) **Hand carriage by four bearers**-On the command: "Hand carriage by four bearers -List Stretcher, all four bearers stoop together, grasp the poles with their inner hands rise together holding the stretcher at the full extent of their arm.

(aa) **Advancing**-On the command "Advance" all will step off with the inner foot. The bearers must keep their knees slightly bent and walk with a relaxed gait.

(ab) **Retiring**-On the command: "Retire" the squad will retire by wheeling and not by turning

(ac) **Lowering a loaded stretcher**-On the command: "Lower Stretcher", the four bearers will stoop, gently lower the stretcher to the ground and rise together.



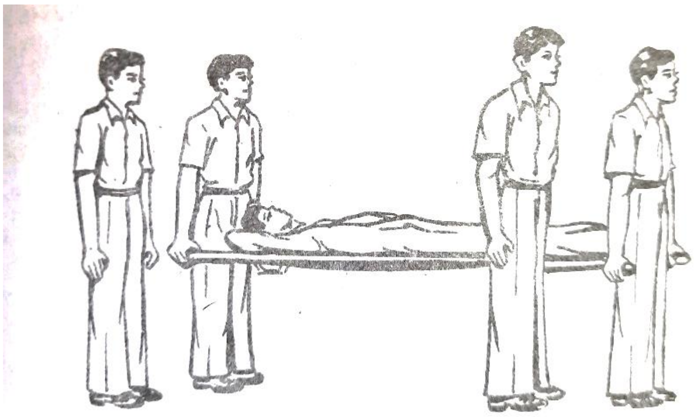
(ii) **Hand carriage by Two hearers**-On the command: "Hand carriage by two bearers-Lift Stretcher, Nos. 2 and 4 will take a side pace over the handles of the stretcher and if they decide to use slings will pick them up, place them over their shoulders and on the handles the stretcher. They will then rise steadily together keeping the stretcher level. Nos. 1 and 3 will tarn inwards to assist. No 1 particularly can help to prevent the casualty's feet catching on the buttocks of No. 2. Nos. 1 and 3 will then turn to face the feet of the stretcher.

On the command: "Adjust slings", "Adjust Slings", Nos. 1 and 3 turn to the left and adjust the stings of Nos. 2 and 4 respectively.

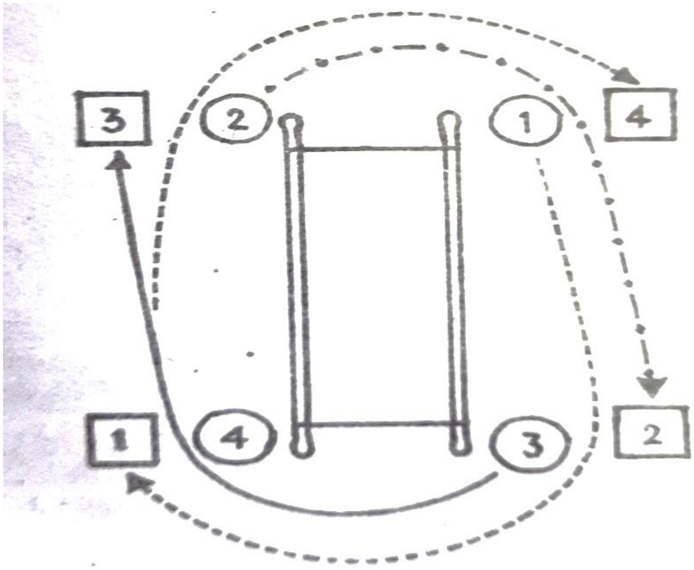
(aa) **Advancing**-On the command: "Advance", Nos. 1, 2 and 3 will step off with the left foot and No. 4 with the right. The bearers must keep their knees slightly bent and walk with a relaxed gait.

(ab) Retiring-On the command: "Retire", the squad will retire by wheeling and not by turning

(c**) Lowering loaded stretcher**-On the command: "Lower Stretcher", Nos. 2 and 4 stoop slowly, gently lower, the stretcher to the ground and rise together. If slings are in use Nos. 2 and 4 will remove them after lowering the stretcher, step over the handles to their former positions, and place the loops of the folded slings over the near handles and the ends over the other handles.



(h) **Relieving bearers by changing numbers**-On the command: "Change Numbers" Nos. 1 and 3 will turn about and the whole team will then step off together. Nos. 3 and 2 wheeling round the ends of the stretcher and all moving round two places clockwise. Each bearer will halt in the position of the bearer whose place he has taken and the new Nos. 1 and 3 turn left about so that all again face the foot of the stretcher.



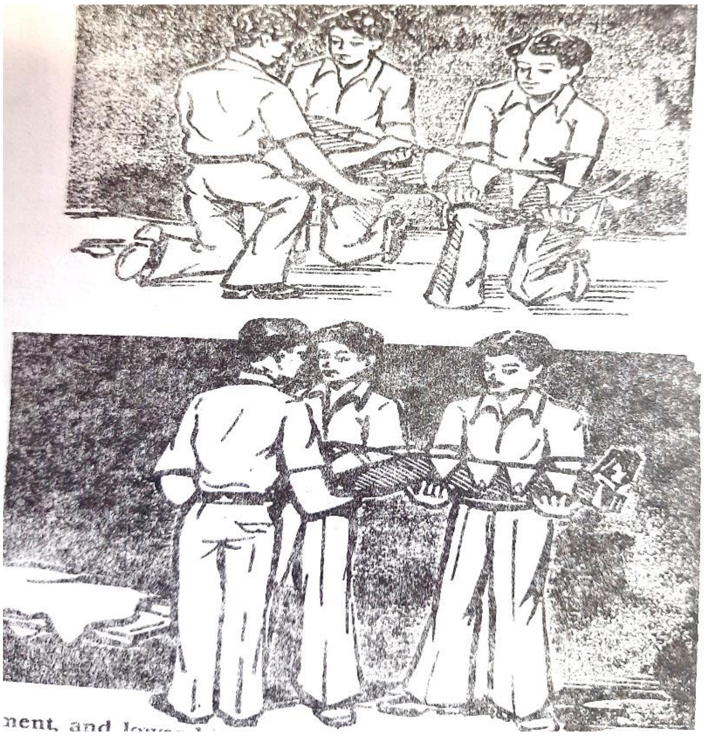
Change Bearers

(i) **Unloading the stretcher**-On the command "Unload Stretcher", the bearers will adopt a similar procedure to that carried out for loading the stretcher. If the casualty is lying on a blanket, the blanket lift should be used; reversing the procedure (described on page 27). Where there is no blanket, after the casualty has been lifted to the bearers knees, No. 1 will lift the stretcher and carry it three paces beyond the casualty's feet and when the casualty has been lowered to the ground, bearers will match and take up their normal position on the open stretcher.

(j) **Closing Stretcher**- On the command: "Close Stretcher, Nos 2 and 3, turn inward and close the stretcher by pushing in the poles after traverse bars have been unlocked, folding the canvas on itself and buckling the straps tightly round the stretcher behind the traverse bars.

(k) **Returning blankets and stretcher**-At the end of the exercise No. will give the command: No:3 "Return Blanket". No 4 "Return Stretcher" Nos. 3 and 4 right turn quick march. The procedure to be followed by Nos. 3 and 4 is similar to that carried out for collecting blankets and stretcher.

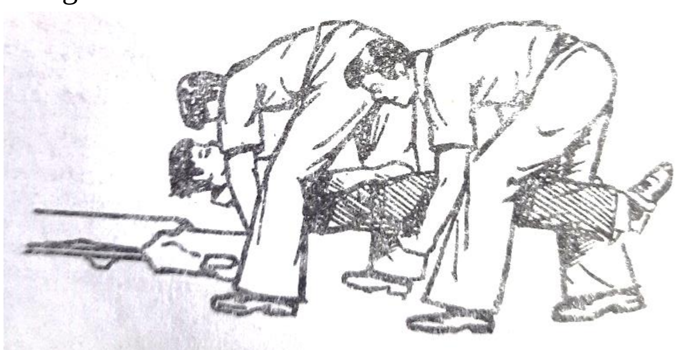
13. **Three hearer drill-**The stretcher will be placed at the casualty's head, in line with his body. No. 1 kneels on the left knee on the injured side opposite the casualty's knees and passes his hands under the casualty's legs. Nos 2 and 3 kneels on their left knees on opposite sides of the casualty facing each other and passing their hands under his shoulder and hip, lock their finger by the hook grip. On the command: "Lin", the bearers will rise to the erect position and, moving by side paces, carry the casualty head foremost over the foot of the stretcher, the horizontal position of his body being maintained



throughout the movement, and lower him carefully on the stretcher. When unloading, the casualty will be lifted and carried head foremost over the head of the stretcher.

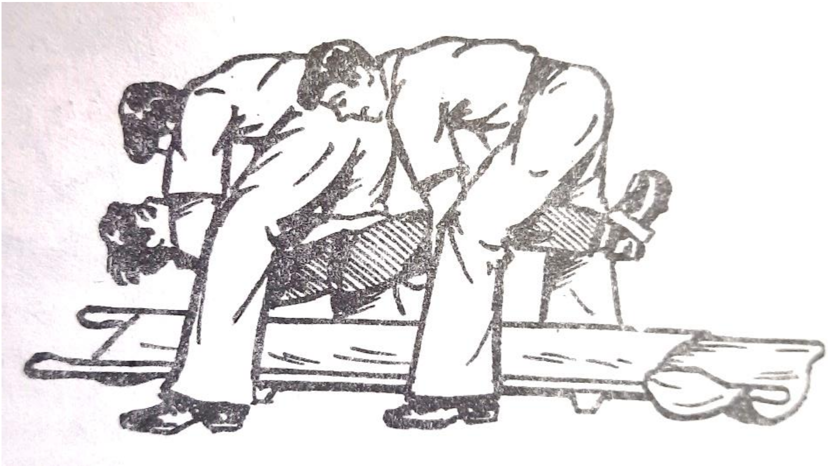
14. **Two bearer drill-**This drill will be used in mines and narrow cutting where space is limited. The drill will be as follows: -

(a) **Lifting the casualty-** Both bearers will stand astride the casualty, No. 2 at the head, placing his forearms under the casualty's shoulders; No. 1 about the knees placing his left hand beneath the casualty's thighs and his right below the knees. When both are ready No. 1 will give the command "Lift"."



(b) **Advancing**-No. 1 will give the order "Advance", and both will step off together with the left foot, taking short even paces and stooping so that the body of the casualty is not far from the ground. They will advance till the casualty is over the stretcher when No. 1 gives the order: "**HALT-LOWER**".

On the command: "Halt-Lower", the casualty is lowered gently on the stretcher. Both bearers then take up position on the left of the stretcher ready for lifting No. 2 at the head and No.1 at the foot.



15. **Rules for carrying a casualty on stretcher**-As a general rule, carry a casualty feet first. The exceptions are:

(a) When carrying a stretcher upstairs.

(b) When going uphill with a casualty whose lower limbs are uninjured.

(c) When going downhill with a casualty whose lower limbs are injured.

(d) When carrying a casualty to the side or foot of a bed.

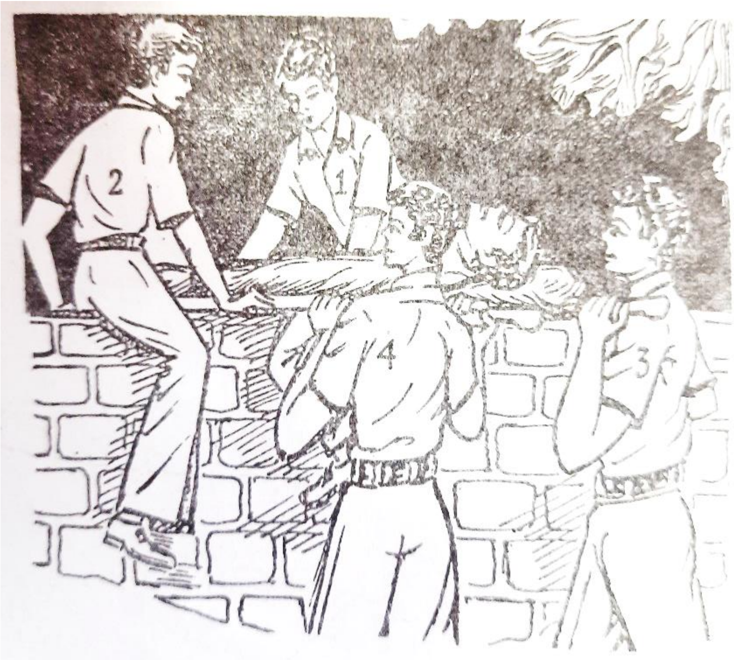
(e) When loading an ambulance

16. **Handling of stretchers in difficult situations**.

(a**) Uneven ground**-If possible the stretcher should be carried by four bearers and kept as nearby level as possible. This can be done and the casualty prevented from falling off by each bearer independently adjusting the height of the stretcher as necessary. Over very uneven ground for short distance the four hearers should face inwards.

(b) **Ditch crossing-**The stretcher is lowered with its foot one pace from the edge of the ditch Nos. 1 and 2 bearers then descend. The stretcher is now advanced, Nos. 1 and 2 in the ditch supporting the front and while the other end rests on the edge of the ground above. Not. 3 and 4 then descend. All the bearers now carry the stretcher to the opposite side and the foot of the stretcher is made to rest on the edge of the ground, while the head is supported by Nos. 3 and 4 in the ditch. Nos 1 and 2 climb out. The stretcher is lifted forward on the ground above, and rests there while Nos. 3 and 4 climb up.

(c) **Wall crossing-**The stretcher is lowered with the foot about one pace from the wall, the bearers then stand to stretcher. Nos 2 and 4 on the left, Nos. 1 and 3 on the right. They turn inwards, stoop down, grasp the poles with both hands, and rise slowly lifting the stretcher. holding it level at the full extent of the arms. Then by side paces they advance to the wall. raise the stretcher and lift it on to the wall, so that the front runners are just over the wall. No. 2 then crosses the wall, and takes hold of the front handles. No. 1 then crosses the wall: they grasp the poles, lift the foot of the stretcher; all the bearers then advance and rest the rear end of the stretcher, on the wall. The rear runners should be kept on the near side of the wall otherwise the handles may slip. No. 4 then crosses the wall and takes hold of the left pole. No. 3 then crosses the wall and takes hold of the right pole. The bearers then advance until the stretcher is clear of the wall. The stretcher is then lowered to the ground.



(d) **Movement over debris**-A stretcher should, whenever possible, be carried in the horizontal position. There may be times when this is impossible as the casualty may have to be carried over debris and bearers will have to climb up and down piles of rubble. In such cases 4 or 6 bearers are an advantage. If four bearers are available, one should be at the front end, one at the rear end, and one at each side of the stretcher. When they have to climb over an obstacle or a heap of debris, the bearers at the sides turn inward towards one another and take the full weight of the front end of the stretcher, while the front bearer climbs up on the debris, the front end of the stretcher is then lifted for him to grasp. The stretcher is then advanced, and the bearers at the sides take the weight of the rear end of the stretcher, while the rear bearer climbs on to the debris and grasps the rear end. A similar procedure is adopted when climbing down.

If only two bearers are available, it may be necessary to lay the stretcher down when they reach an obstruction so that they can ascertain the best method of getting over it. The bearer at the front end climbs on to the debris while the bearer at the rear end passes the front end of the stretcher up to him to grasp. The rear end bearer than resumes his position and lifts the stretcher to a horizontal position and the bearers cross the obstacle. Care must be taken to see that the stretcher, if laid down, is resting on each "D" with the bed of the stretcher clear of obstruction so that debris will not move under the weight of the casualty or injure him.

(e) **Movement of stretcher in confined space**- In confined spaces, if there is sufficient height and the casualty has been secured to the stretcher, it may be stood on end and, by grasping the sides, can be moved round sharp corners. Where the height is insufficient to permit of this method being used, as in the case of shelters, a compromise between the horizontal and vertical positions is necessary. The casualty should be carried feet first as far as the middle of the right-angled bend, where the front end of the stretcher is placed on the ground and the rear end lifted as high as the roof will permit. The stretcher can then be worked round the bend, one bearer easing the front end and another the rear end. It should not be turned on its side or height will be lost and difficulties increased. At the same time there will be a risk of the casualty banging against the inside of the bend.

(f) **Crossing.**

(i) **Crossing over gaps**-When taking a casualty out of a damaged building it is often necessary to cross a gap in the floor. A ladder may be used as a bridge. Alternatively, two or more joists may be laid across the holes as illustrated below. They should be twice as long as the hole to ensure that they rest on the sound joints of the damaged floor.

(ii) **Gaps in debris**-It is wise to use six bearers as a safety precaution when crossing a pile of debris which contains gaps. Two bearers go across the gap while the remaining bearers turn inwards and, lifting the stretcher, pass the front handles to them across the gap. The two rear bearers support the stretcher as it goes over then relieve the front bearers, who cross the gap and take up their position ready to take over the rear end of the stretcher. The remaining bearers then cross the gap and take up their position at the sides of the stretcher.

AMBULANCE LOADING/UNLOADING

17. (a) **Loading**-The stretcher is lowered with its head one pace from the doors of the ambulance. The casualty will be loaded head first. The bearers now stand to the stretcher. On the command: "Load" the bearers turn inwards, stoop, grasp the poles of the stretcher, hands wide apart, palms uppermost, they rise slowly, lifting the stretcher, holding it level at the full extent of the arms They then take a side pace to the ambulance raising the stretcher evenly to the level of the berth to be loaded. The front bearers place the runners in the grooves, and then assist the rear bearers to side the stretcher into its place and secure it. If slings have been used they should be kept with their stretcher. Many ambulances are provided with upper and lower berths. In such cases the sequence of loading is upper right, upper left, lower right, lower left. It should be noted that this might not be practicable if the ambulance to be loaded is of the single rear door type. In such circumstances the following method of loading should be adopted. On the command "Load", No. 4 will take up position inside the ambulance facing the stretcher and No. 2 will take up position opposite No. 3 with No. 1 between the handles facing the ambulance. Nos. 2 and 3 turn inwards and all three bearers lift the stretcher to the required height, move forward and hand the head of the stretcher to No. 4. No. 2 and No. 3 then move backwards to assist No. 1 who will load the appropriate berth with No. 4.

(b) **Unloading-**Two bearers take hold of the handles at the rear and gently withdraw the stretcher. As it is withdrawn, the other two will take hold of the handles at the front, and taking the weight, lower it to the full extent of the arms; then by side paces march clear of the ambulance, lower the stretcher to the ground. To unload an ambulance with a single door Nos. 4 and I will enter the ambulance with Nos. 2 and 3 on either side of the door to assist No. 1 to descend. The stretcher is then withdrawn from the ambulance and Nos, 2 and 3 receive the head of the stretcher from No. 4. The stretcher is then carried clear of the ambulance and lowered to the ground.

18. **Transfer of casualty to bed-**The stretcher is lowered at the side of the bed. The bearers take positions as for unloading stretcher, Nos. 2, 3 and 4 being on the side farther from the bed. The casualty is unloaded on the knee of Nos. 2, 3 and 4, No. 1 will disengage and remove the stretcher (this may be done by pushing it under the bed). He then joins hands with No. 3. All the bearers rise to a standing position, supporting the casualty on their forearms. No. 1 disengages and goes to the patient's head, and supports it. All bearers then step forward and gently place the casualty on the bed. If the bed is narrow and there is room, the stretcher may be placed on the floor with the head close to the foot of the bed. The casualty may then be lifted over the foot and placed on the bed. If the casualty is lying on a blanket and if the bed is narrow and there is room, the blanket lift should be used, the bearers lifting him over the foot of the bed.

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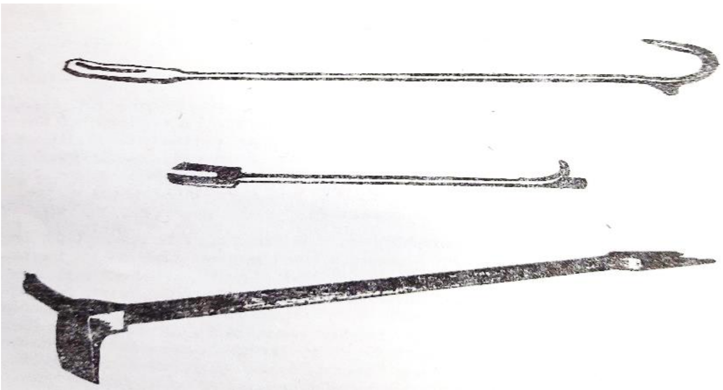
CHAPTER 14

EMERGENCY ENTRY

1. **Introduction**-Knowledge of specific rescue techniques is necessary to carry out a rescue operation involving a collapsed building. All rescue operations normally require the use of several techniques. Selection of the most effective technique under the varying conditions of rescue work often means the difference between the survival or death of a casualty.

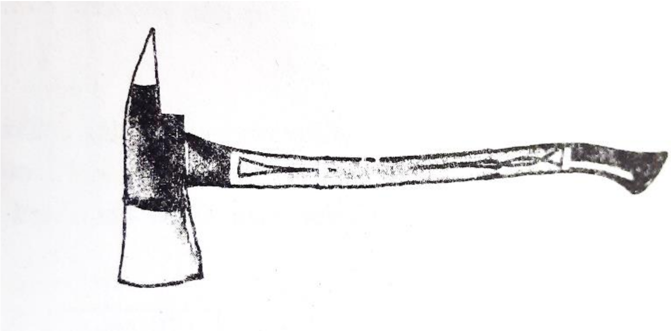
FORCIBLE ENTRY

2 **General**-Forcible entry to the rescuers means obtaining entrance through locked or secured doors and windows and the opening of roofs, floors, skylights, partitions and walls by mechanical means to gain access to the casualties. Before beginning forcible entry the rescuers should make certain that it is necessary to do so as a ladder raised to a second floor window or fire escape may provide a means of entrance. On the other hand, when an area is badly damaged or on fire a fell entry should be made promptly and vigorously because doors and windows are already damaged and prompt entrance may prevent further damage to more important structural members and to contents such as expensive machinery and stock and trapped individuals. Breaking of a lock or prying open a window in forcible entry in many instances means the destruction of the door or window or other part of the building In his eagerness to protect property, the rescuers must not destroy property. As protectors of property, good rescuers strive to avoid needless damage.



Forcible entry tools Top: Claw tool and door opener used to force doors, pry of locks, remove based-board long weighing 12 ½ lbs. Centre: Light weight 24 inches claw 6 ½ lbs. Above “Halligan tool” combining book claw punch lock breaker and axe, 8 ½ lbs.

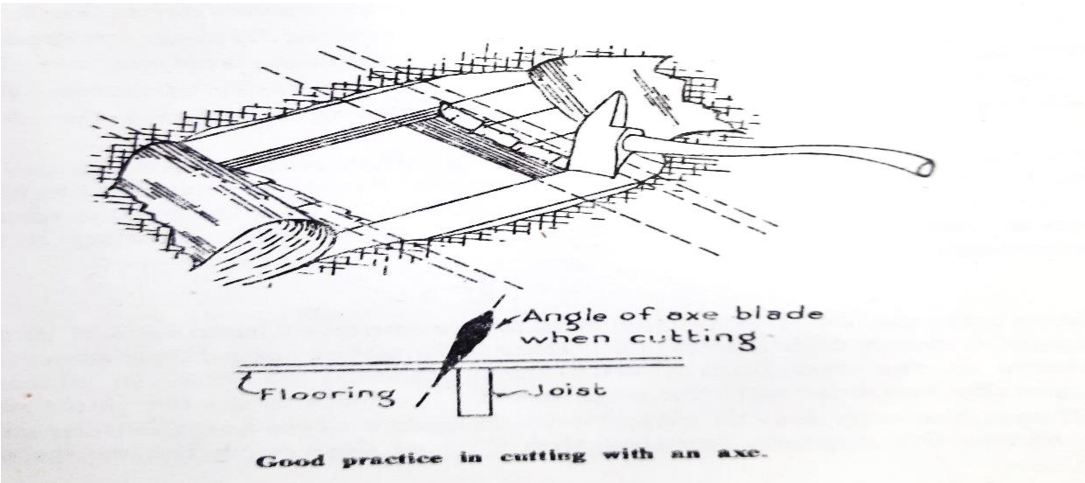
3. **Axe as a Cutting Tool**- The uses to which the pick-headed axe can be put during rescue are many. To an experienced rescuer its adaptability to special uses makes it particularly valuable. It’s one great advantage over a common axe is the pick on the back of the head, which is used for prying ripping leverage, and other jobs such as forcing padlocks. The pick headed axe has several advantages over the flat headed axe. It is easier to carry in a belt, can be used to pull up flooring and roof boards, to open partitions and for pulling lath and plaster in places inaccessible to pike poles. If the fire axe were exclusively for cutting wood free from materials harmful to the blade, a wood chopper's axe would be ideal. If the blade is extremely sharp and the body is ground too thin, pieces of the blade will be broken out when cutting gravel roofs or striking nails and other materials in flooring.



Fire department type axe

If the body is too thick, regardless of the sharpness of the blade, the axe cannot be driven through ordinary flooring. The recommended body thickness is about ¼ inch at ¾ inch from the edge, 3/8 inches at 11/4 inches, and ½ inch at 2 inches from the edge. Measurements are taken at the centre of the blade. The standard fire axe weighs six pounds but some favour lighter or heavier axes. Care must be used in grinding to prevent heating and the consequent softening of the steel. The axe should be ground to preserve the body thickness and not merely to sharpen the blade. After sharpening, the blade may be rubbed lightly over the to take off the keen edge and lessen the possibility of cutting rescuer who may rub against it. An extremely keen edge is not necessary. The shoulder of the handle is left rather thick to prevent breaking should the axe be driven through a floor unexpectedly. The grip is thin to provide elasticity, and should be smoothed to a polish. Paint is not recommended; varnish or linseed oil may be used to prevent roughness and warping.

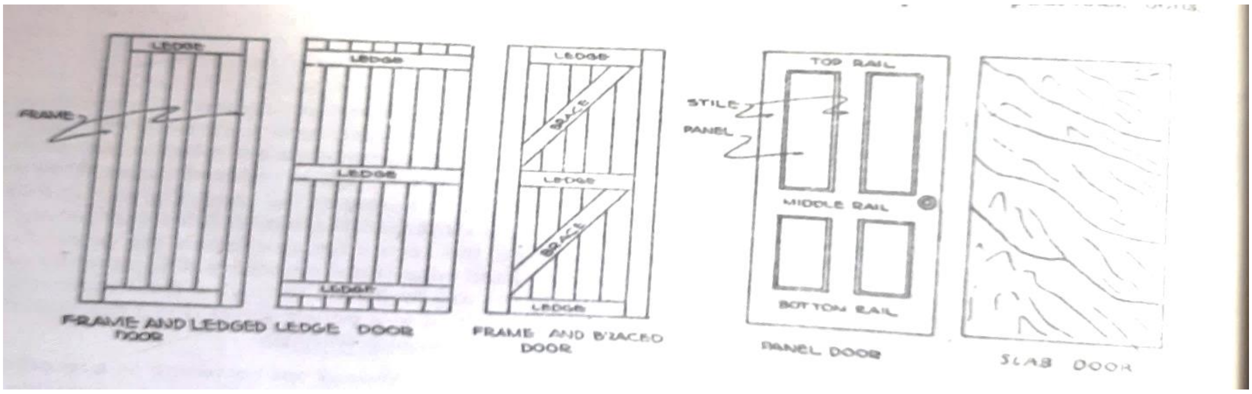
4. **Cutting with an Axe**-When cutting with a fire axe, it should not be swung as a wood cutter uses it, but with short, quick strokes. Using this method, danger of hitting other men or catching the axe in overhead obstructions is avoided, and the axe is under complete control at all times. When cutting flooring, roofing or sheathing, the cut should be made at an angle to the grain of the wood, instead of straight across it. About 60° is the correct angle. Wherever possible, diagonal sheathing should be cut in the direction towards which the sheathing runs. In this manner the chips have a tendency to split out, while if the cutting is done against the sheathing the axe is opt to bind. If possible, the cutting, should be done across the grain of the board instead of straight down. This gives a firmer object to cut against. For the same reason,



Good practise in cutting with as axe.

cutting should be done as close to the joist or stud as possible. Practice of a standard stroke is desirable to develop the proper technique of using the axe When cutting flooring or straight laid sheathing, it may be necessary to cut at a greater slant from the perpendicular than in the case of diagonal sheathing. In cutting through a lath and plaster wall it well to remember to cut in a diagonal direction to the grain of the wood instead of straight for the reasons stated. A rescuer should be able to cut right and left-handed. Cutting in difficult corners and under obstructions can be done in a workman like manner by men who have been schooled in the proper way to use a fire axe.

5. **Opening Doors**-Fig below illustrates the various types of building entrance doors. Ledge doors, sometimes called batten doors, are found in warehouses, storerooms and bars. They are made of built-up material and must be locked with surface locks, either hasps and padlocks, bolts, or bars.

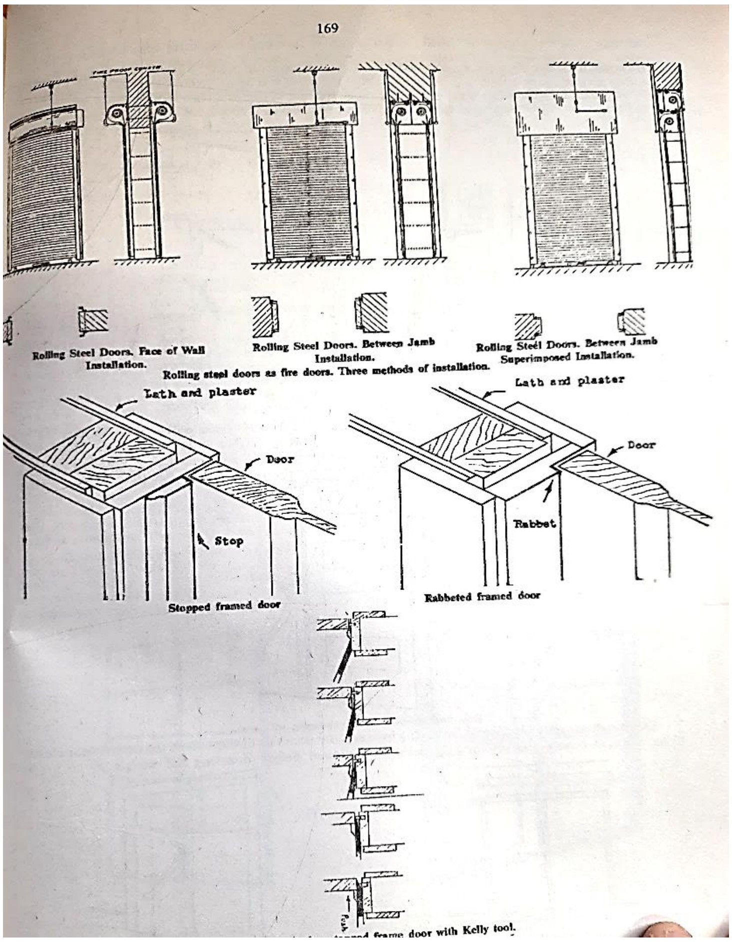


Common types of door construction

Panel doors may be of several types, either cross or vertically panelled. The panels are of thin material, dadoed, not glued, into the stiles and rails. Either surface or mortised locks may be used: and hinges may be either full surface, half surface of hidden butts. The hinges generally have loose pins that can be removed. Front doors of offices often have glass panels. Slab doors are made of veneered material. A white pine core is generally used, and the veneering may be of any desired hand wood. Slab doors are very solid and not easily sprung. Industrial doors, such as are used in garages warehouses and factories, are made sliding swinging, sliding-folding, overhead lift, overhead folding or overhead rolling Double sliding doors are locked together and are very hard in force from the outside. Once the lock is released, overhead lift doors are easily operated. These doors are usually locked with sliding bars that must be broken or sprung to release the door.

Overhead rolling doors made of steel offer the greatest resistance of all the forcible entry, because the door cannot be raised except by operating the gear. Prying on the door is likely to spring it so that it cannot be operated. An accepted practice is to install a cast iron plate in the brick wall near the chain. This plate may be shattered with a good blow, thus making it possible to reach the operating mechanism.

The way in which the door is lunge and the manner of locking will determine the method of penning. The smaller doors of industrial buildings are either set against stops in the frame or against rabbeted shoulders in the door jamb. With the exception of those in places of public assembly. e doors usually open in, and the one forcing the door is on the jamb side. If the door is only d in the frame, the stop may be raised with a sharp wedger and the door swung clear of its fastening. Fig below shows the steps in opening this type of door with the wedge of a claw tool.

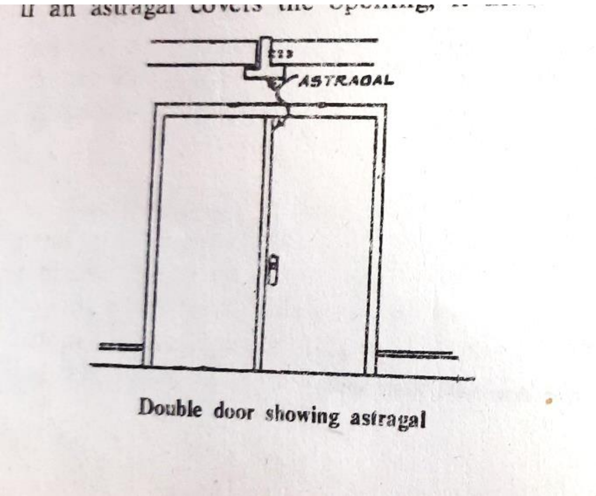


Step in springing stopped frame with Kelly tool.

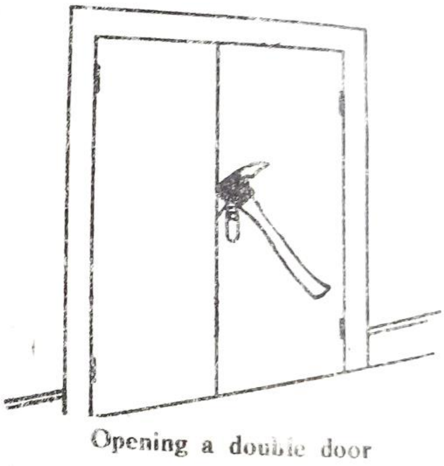
However, if the door is set in a rabbeted frame, the opening is not made so easily. Below shows how such a door may be opened, but it is evident that either the jamb will be split away or the lock bolt broken. Fig below shows how the same door may be opened with the wedge of a claw tool by using care. The de and the jamb will be damaged, but the door can be closed as it could not if it had been battered open.

A door opening out may be opened by inserting a wedge, either a claw tool or the blade of an axe, in the crack between the door and jamb and prying the two apart unit the belt clears.

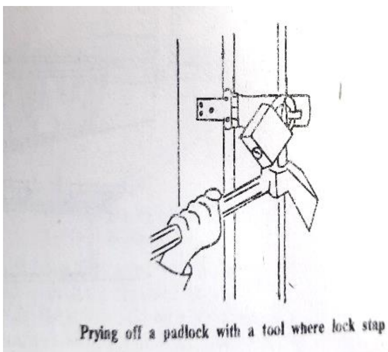
Double doors may be opened by prying between the doors until the bolt of the active door clears. If an astragal covers the opening, it must be removed before inserting the wedge.



Double door showing astragal

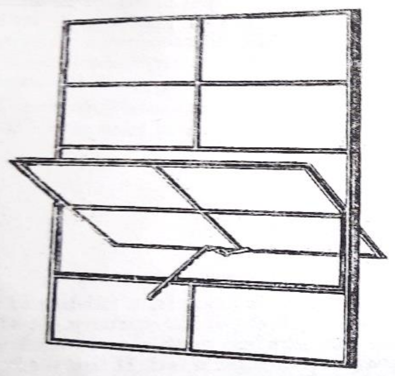

Opening a double door

Night latches should yield to the same prying as mortised locks. If they do not they may be forced off by ramming the door with a heavy object, as they are fastened on the surface of the door with screws. Sometimes this can be done with a man's shoulder. Overhead lift doors may be forced by prying upward at the bottom of the door with a crowbar, claw tool, or other good prying tool. Once the lock bar is broken the doors should open easily. Single hinged doors, such as on warehouses and stables may be opened with a blow from the pick of fire axe or pried open with the axe pick. Heavy glass doors such as those occasionally found at front entrances of office structures and merchandising areas, are very cosily and should not be forced unless absolutely necessary or unless fire has already damaged the door beyond repair. The lock cylinders of such door can usually be knocked out by a sharp blow with an appropriate tool and this may prevent destruction of the door. Where it is necessary to break the door it should be struck with sharp blows with the pick of the fire axe but with the fire fighter wearing

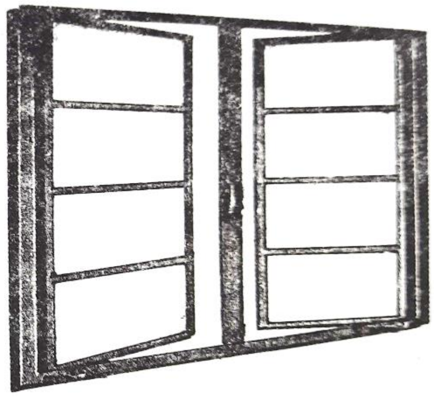

Prying off a padlock with a tool where lock stap

Prying off a padlock with a tool where lock step

appropriate fire clothing and standing with face away from the door to avoid possible flying splinters of glass. In opening any door or window of an area seriously involved in fire there is danger to the operators from flame and smoke when the opening is made. Generally, it is best to work from one side of the window or door opening Steel rolling doors are practically impossible to open. For reasons previously stated, they should not be pried. Many times double warehouse doors are secured with a bar dropped into stirrups on the inside of the wall. To make forcible entry the door can be battered in. Occasionally it may be necessary to make a breach at the wall with a battering-ram. The breach should be a point that will permit slipping the bar from the stirrups. In the case of ordinary brick walls, to better a hole through the wall large enough for a man to enter and unlock the doors from the inside is sometimes the quickest and last destructive method of access.

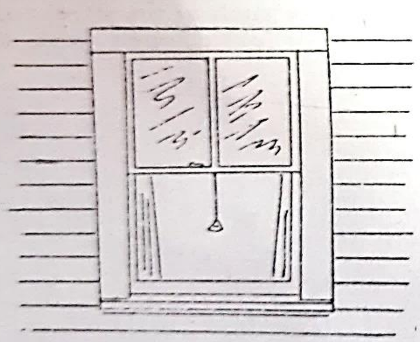


Factory type window

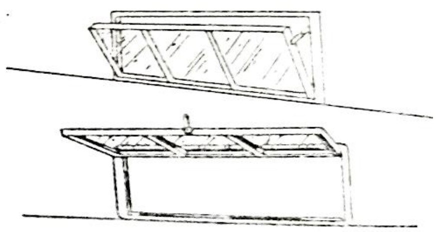


Casement type window

6. **Opening Windows**-Industrial and office building windows, if of reasonably modern construction, are likely to be of factory type. If older, they may be of check rail type similar to those in most dwellings, or casement type. Some basement type windows will be found. Factory type windows are made with metal sashes. The sash is often set solidly in the frame and only a part of it can be opened. The movable part generally is either pivoted at the centre or hinged at the top. Since factory type windows are glazed with small size glass. It is easier and less destructive to break a glass near the latch and reach in to unfasten it. The rough edges of glass be cleaned out before the hand is inserted. In case wired is encountered, it should be removed from the sash.

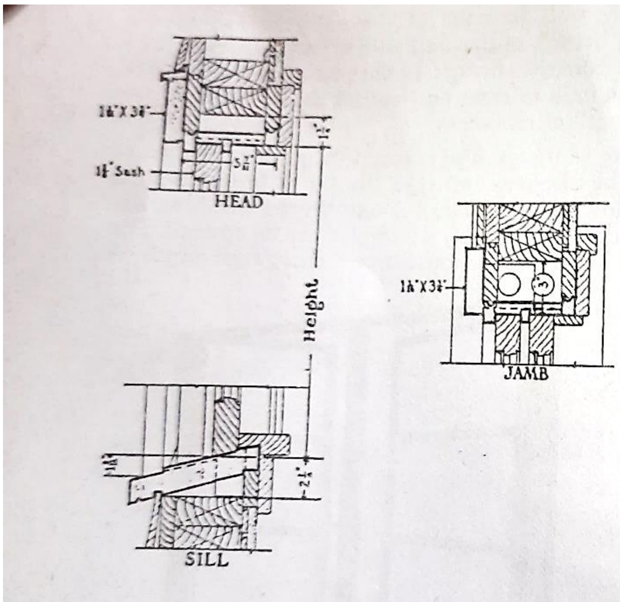


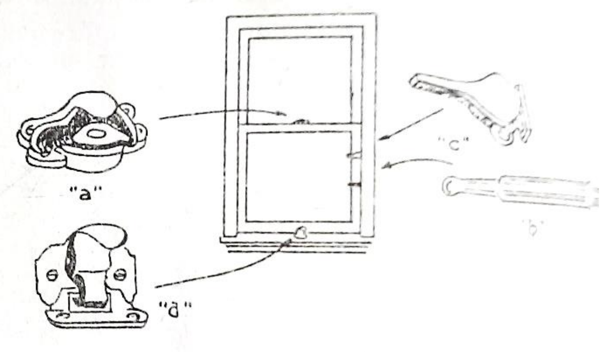
Check rail window



Basement type windows

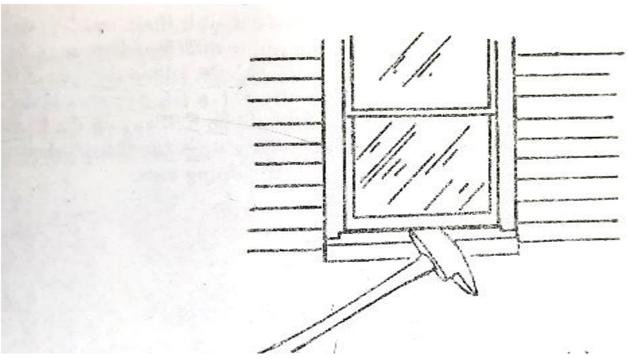
The check rail window consists of two sashes that meet horizontally and is the common type used in residences. If the sashes are hung with weights, they will be locked at the centre of the check rail, that is the upper and lower sashes will be locked together. If the window has no weights the sash will be locked with bolts in the window stiles or a friction lock may be found that secures the sash by pressing against the window jam There may be a bottom rail catch.





Details of check rail window **Various locking devices used in check rail windows**

Basement windows can be opened with a claw tool much the same as a door in a rabbeted frame. If the prying is done it the centre of the lower tail the lock can be pulled off or sprung. It should be remembered that prying with a wedge is the principal operation in opening both doors and windows. The man's as the claw tool, or any other wedge-shaped instrument can be used. If the wedge is wide and thin, the entry can be forced with little damage to the building. When needed, a door can be closed by reversing the operations. Check rail windows can be opened by prying upward on the lower sash rail If they are locked on the check rail the screws of the lock will give and the sashes will separate. If locked with bolts, they must be broken or bent before the sash will rise. Caution should be taken that the prying is done at the centre of the sash else the glass may be broken. However, if the check mil latch is on the side,

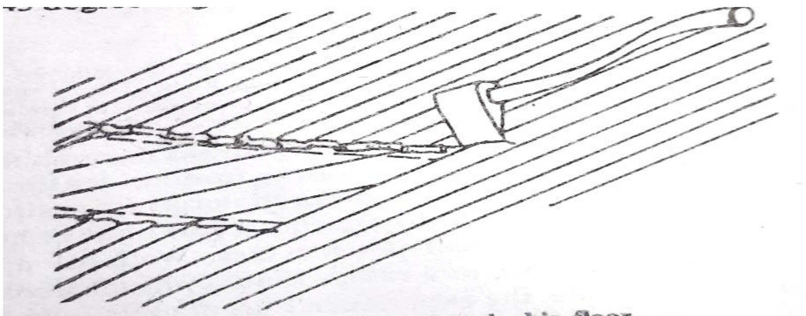


Frying up a lower rail with axe to open window.
This will remove the latch which is held by small screws.

the pry should be made directly under it. Opening windows to provide ventilation on upper floor of buildings can be done from the inside, possibly after entry has been made from a ladder or fire escape using an axe blade where necessary to gain entrance. If the smoke is too severe for inside work the chances are that window glass within reach of ladders will have to be broken out with ate or pike pole although occasionally nearby windows can be forced up or down with a pike pole. Per sons opening windows must be careful to see that other fire fighters are not endangered by vented flame, smoke or falling debris. Casement sashes are hinged to the window jambs and meet vertically. Casement windows may be opened much the same as double doors. Generally, they are locked securely. Breaking the glass usually in the easier and most economical form of entry. Basement sashes, if made of wood, generally are hinged at the top and locked at the bottom. Metal sashes may be hinged either at the bottom or top.

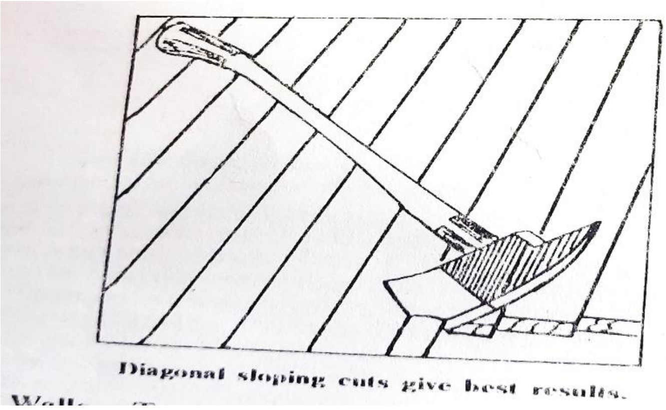
7. **Opening Roofs**-For the purpose of this study roofs are divided according to the type of covering construction i.e. shingle roofs, composition roofs, and metal roofs. All roofs made of small sections of material fastened to the sheathing, such as wood, composition, metal or asbestos shingles, are included in the group of shingle roofs. The very nature of shingles makes it an easy matter to remove them in forcible entry, for they are nailed to the sheathing. A shingle roof of any type can be opened by stripping off the shingles and cutting away the sheathing. The fireman's axe is the best tool for both operations. Composition roofs are made up of one to six sheets of roofing material, generally asphalt-impregnated felt nailed to the sheathing and cemented together with asphalt which is spread over the entire covering to harden as it cools Some roofs have gravel spread over the hot asphalt. The sheathing consists either of one inch shiplap laid tight on roof joists or solid concrete (use in newer-type buildings). These roofs require more care in opening, not because they are harder to open, but because they are more difficult to repair. The covering should be ripped and rolled back after which the sheathing may be cut away to make an opening the size desired. The roof should be sounded before cutting, to determine the location of the joists. Cutting should be close to the joist, making the operation easier and the hole rectangular and more easily repaired. Metal roofs, generally of tin plate are sheets crimped and soldered together as one sheet and nailed. Always work with the wind to your back so you are not affected by gases or fire coming through the opening.

9. **Opening Floors**-Wood floors are usually laid double on 2 inch joists set 16 inches on centres. The sub-floor is laid at a 45 degree angle to the joists and the top floor



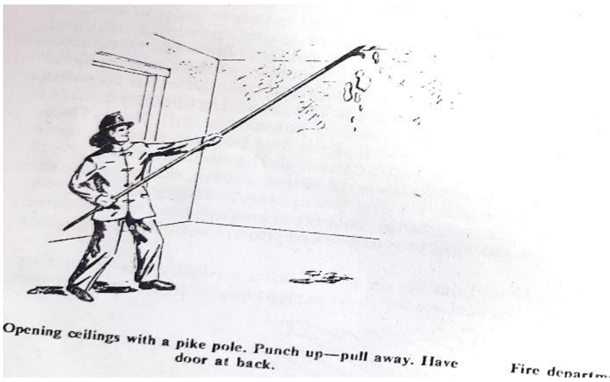
Cutting through a double floor.

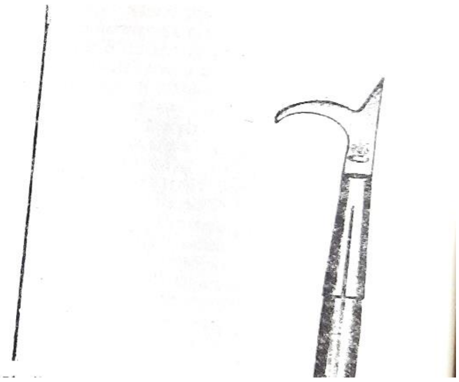
at right angles to the joists. Floors may be opened much the same as a flat roof, except that in the case of a double floor, aistinet cutting jobs are required, due to the fact that the finish-floor and sub-floor ran in different directions. As nearly as possible the joists should be located by sounding and both cuts should follow the side of the jo toward the required opening. It has been found that the best results with a fire axe are obtained with short, hard strokes as shown in below. The force-applying hand should be halfway up the handle and the feet should be fairly wide spread to keep a good balance. The cutter always should stand outside the space to be opened. The best results will be obtained by diagonal sloping cuts.



Diagonal sloping cuts give best results.

9. **Opening Ceilings and Walls**-To open a plastered ceiling it is first necessary to break the plaster, then pull off the lath. A pike pole is good for this job. Metal and composition ceilings may be pulled from the joist in a like manner. Board ceilings are not so easily removed due to the inability to stab the pole through to get the hook fastened above. Some departments have plaster hooks to use for this purpose.



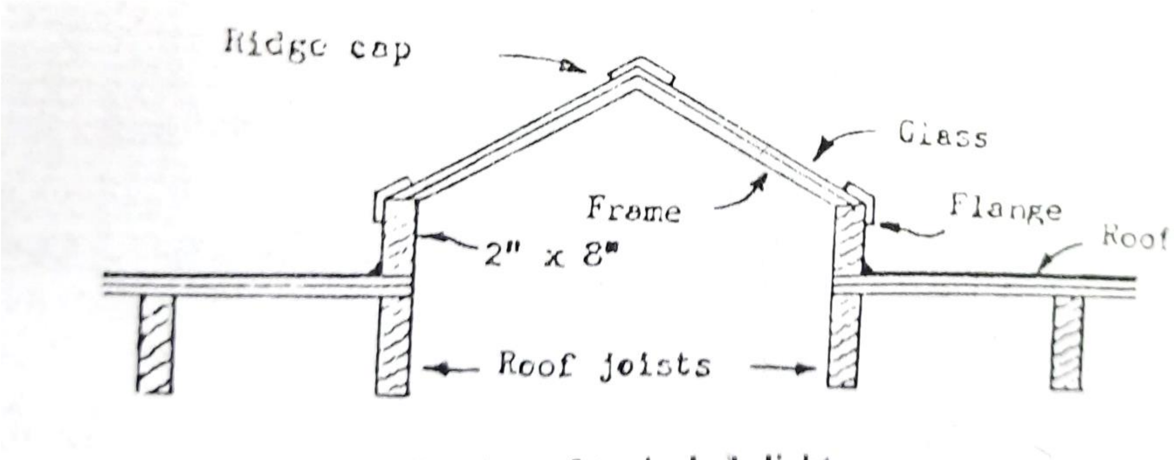


Opening celling with a pike pole. Punch up pull away. Have door at back

Fire department pike poles of plaster hooks. Left: Aluminium construction. Right: Forged steel pike and hook-on Oregon pine pole. Pike poles come in various lengths -8 ,10 and 12 ft. are common size.

The blades are held apart with springs and expand after being forced through the ceiling. The following precautions should be taken: The operator should stand away from under the space to be opened, and when pulling, pull down and away, thus preventing ceiling material from dropping on his head. No rescuer should attempt to pull down a ceiling without wearing a solid hat or helmet, and he should be near an open door through which he can retreat if necessary. Walls of moderate height may be opened with an axe or other short forcible entry tool rather than a plaster hook. Unless excessive heat discoloration or other signs or life are visible, the experienced fireman usually will pay off a mop board to investigate before damaging plaster.

10. **Opening Skylights**-The general construction of a skylight is illustrated in fig below. The metal frame of the light itself slip over the roof-flanged opening, and by prying under the edge the entire skylight may be pulled loose and lifted. If the light cannot be lifted, and if time permits glass may be taken out by removing the metal strips or putting that covers the joints. However, again, glass is much cheaper to replace that the roof structure that may become involved through failure to vent the fire.



Section of typical skylight.

11. **Breaking Glass**-Glass in either a door or a window may be broken easily by using the flat side of a fire axe. The man breaking the glass should stand to one side and strike the upper part of the glass first. In this way, broken glass cannot slide down the axe handle to cut the hands. After the glass is broken out all jagged pieces should be removed from the sash. This can be done with the pick of the are Removing all pieces will avoid cutting the man who goes through the sash, and will prevent injury to hose, ropes, or other material that may be passed through the opening.

12 **Carrying Forcible Entry Tools**-The efficient rescuer is the one who can work rapidly and safely at all times. To do so, definite practices in carrying tools are as important as knowing how to use them. Tools with sharp hooks or sharp edges should never be carried on the shoulder. Should one stumble with such a tool on his shoulder, the reaction from the stumble would cause him to release his grip on the tool and it might fall against his head or body, or even strike another person. An axe should be carried as shown in Figs. below. Any tool with a hook such as a claw tool, should be carried at the side. with the hook forward. A pike pole may be shielded by placing a piece of old garden hose over the points which should be kept shielded until the pole, where it is to be used

CUTTING THROUGH WALLS

13. **Types of Walls**-It is possible to tell on examination of a brick wall whether it is jointed with lime or cement. When damaged, lime jointed brickwork tends to all to pieces and the individual bricks lie about almost undamaged, whereas walls built with cement usually break up into chunks with the fracture going right through the bricks as well as the joints. Wall may belong to one of the following classes: -

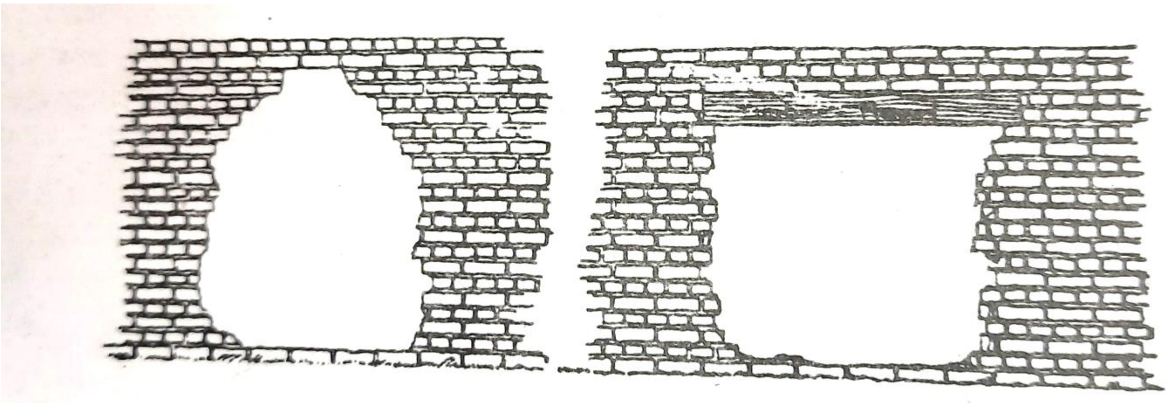
(a) **Brick (with lime mortar)** -Walls built with lime mortar especially if they are old, are usually quite easy to demolish or pierce. As a rule, the bricks can be withdrawn whole without difficulty. The hole should be made in the shape of an inverted V. If there is any risk of, I collapse it may be necessary to put some form of headpiece to prevent the bricks immediately over the hole from falling in.

(b) **Brick (with cement mortar)-**Cement mortar is much stronger than lime mortar, it is, in fact, as strong as the brick itself. Holes sufficiently large for rescue purpose can, therefore, be safely made in these walls without special precautions.

(c) **Stone-**Walls of stone may be of various types, with small and/or large stones and different ways of bonding Only where a hole is cut through a wall made of fairly small loose stones any support needed at the head. Stone basement walls are usually thick and difficult to cut.

(d) **Concrete-** It is almost impossible to cut with any speed through concrete (especially reinforced concrete) unless a pneumatic tool is employed. Pneumatic tools, if required, should be called for without delay. Prior consideration should be given to the vibration likely to be caused by their use and the psychological effect upon trapped persons.

14. **Procedure-**Except in the case of a concrete wall the procedure in piercing a wall should be to cut a fairly small hole first and then to enlarge it to the required size. With concrete walls, unless they are very thick, it is better to make a cut round the edge of the piece to be removed. If the walls are reinforced, the cut must be deep enough to reach the reinforcing bars so that these can be cut with reinforced, the cut must be deep enough to reach the reinforcing bars so that these can be cut with hacksaws, shears or an acetylene cutter. Unless any other considerations have to be taken into account, a wall should be cut through the part where it is thinnest, this is usually behind the fireplace. When cutting into walls or floors of large buildings great care must be taken to avoid weakening the main beams and columns supporting the building. To men with experience of building these parts of the structures are easily recognised. Those without experience or training should not interfere with anything beyond a simple brick wall except on the advice of an experienced man.

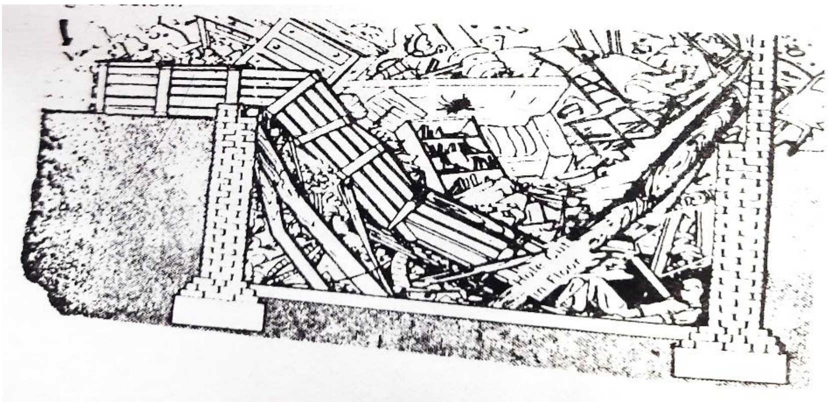


Cutting through brickwork.

Where a building has been damaged by a bomb, even parts still left standing and apparently sound may be severely shaken and cracked. When therefore, walls are being cut away, vibration should be avoided as it may lead to further collapse. When cutting through walls or floors of large buildings, locate sections of the structures in which cutting can be done most quickly and safely. When cutting through walls, rescuers must be sure that support beams and columns are not weakened. After a building has been subjected to damage, the parts left standing may appear sound although badly shaken and cracked. Therefore, when cutting away wall sections, especially with air hammers, care must be taken to prevent further collapse. Openings large enough for rescue purposes usually can be made in brick walls without danger of the masonry's falling. The bricks should be removed so that the opening is arch-shaped. Concrete walls and floors, especially when they are reinforced are difficult to cut through. Pavement breakers or other power tools will be helpful. Crews should request such equipment from the city department responsible for street maintenance or from other sources. In all walls and floors except concrete, the best method is to cut a small hole and then enlarge it. With concrete, however, it is better to cut around the edge of the section to be removed. If the concrete is reinforced, the reinforcing bars can then be cut by a hacksaw or torch and the material removed in one piece. If a torch is used, he sure explosive gases are not present, and that flammable materials are not ignited. A fire extinguisher should be kept nearby.

TUNNELLING

15. **General**-Tunnelling is used to reach casualties, usually when their location is known. It is slow, dangerous work and should be undertaken only after all other methods have been exploited. It is used primarily for connecting existing voids Tunnelling should be carried out from the lowest possible level, should not be used for general search, and must not be aimless. Occasionally, however, tunnelling may be used to reach a point, such as a void under a floor, where further searching may be conducted. Refer figure below.



16. Debris tunnelling is very different from tunnelling through undisturbed earth, although strutting and bracing are necessary in both cases. The speed at which a debris tunnel can be con structed varies with the nature of the debris and the size and shape of tunnel required. Because debris is unstable and key beams have to be left in place, the shape and path of a tunnel through debris soften irregular. For this reason, a definite pattern of timbering, as in a tunnel through earth, may not be possible.

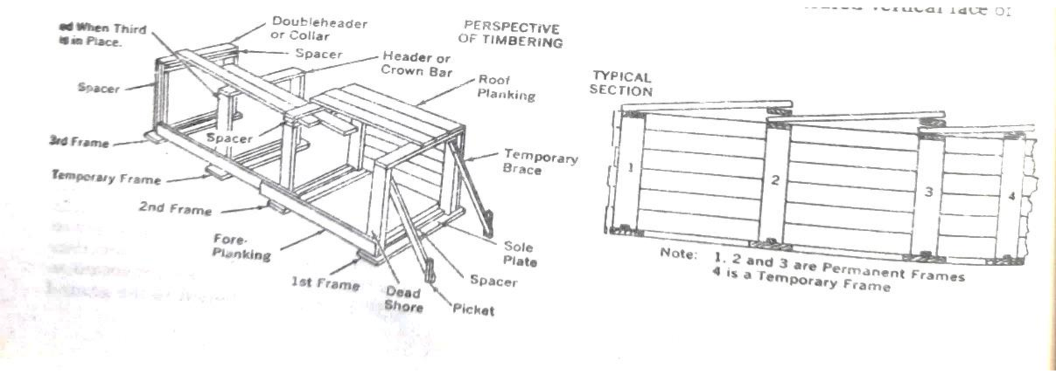
17. **Size of Tunnel**-A tunnel must be of sufficient size to permit rescuers to bring out casualties. It should not be constructed with abrupt turns. Tunnels as small as 30 inches (75 centimetres) wide and 36 inches (90 centimetres) high have proved to be satisfactory for rescue work: Whenever possible tunnels should be constructed along a wall, or between a wall and a concrete floor to simplify the framing required. Constructing a vertical shaft may be considered a form of tunnelling for vertical or diagonal access. Usually, these shafts are made through the earth after debris has been cleared from the surface. They are often made to reach a point where a basement wall must be breached Shafts should not be sunk where water or gas service lines enter buildings. Layers of soil and gravel carrying water should be avoided.

18. **Obstacles in Tunnelling**-In burrowing or cutting through debris, a great variety of obstacles have to be overcome, worked round or removed; anything from a steel joist to grandfather clock may be encountered. Obstructions such as beds, projecting timber, or steel joists may have to be cut either with a saw or any oxy-acetylene cutter, but before this is done,

the piece to be cut must be firmly secured in position so as to prevent collapse as soon as the cut is made, particularly as the obstruction in question may be carrying a considerable weight of debris which, on collapse, may fall and block the tunnel. Indeed, it is so difficult to tell how an obstruction will fall or twist after being cut that it is best to avoid cutting a beam or girder, if it is possible. When an oxy-acetylene cutter is to be used to remove metal obstruction, an operation so difficult and dangerous that it is safer and probably quicker to remove the obstruction by some other method, great care must be taken to see that the debris round about is not set on fire. The best safeguard is to use a stirrup pump to soak any combustible material and to keep the pump in readiness for dealing with any fire that may be caused It must also be remembered that the air in a debris tunnel is liable to become foul when an oxy acetylene cutter is being used; unless, therefore, some means is employed to circulate the air conditions may become unfit in and trapped people may suffer. When heavy obstructions such as blocks of masonry and large portions of brickwork are encountered, it is usually quicker to work a way round, over or under the obstruction in preference to cutting a way through. Large service gas pipe and water pipes may frequently, obstruct debris tunnelling. It is always best to avoid cutting these pipes; but when this has to be done, the public utility services should be informed of the position, and be asked to cut off the service. Even after this has been done there may still be gas or water in the which will escape immediately the pipe is cut if preventive action is not taken. No gas pipe above 1 ½ inch diameter should be cut without supervision from a gas repair squad. As the pressure in gas pipes is low, when a pipe has to be cut, bungs of rag, plasticine or clay pushed into the open ends of the pipe should suffice to stop the escape.
Both ends of a gas pipe must be stopped up in this manner. The pressure in water pipes is much greater and large pipes of 3-inch diameter and over must never be cut but tunnelled under or over. Small service pipes of lead, copper or alloy, up to 1½ inch diameter, may be cut after being closed by hammering fat to reduce the pressure, and when cut, both ends scaled by being turned over on themselves and again hammered. Small iron pipes, up to 1inch diameter, either from supply cisterns or on hot water or central heating systems which may still contain water can be cut and the flow stopped by driving in tapered wooden plugs Pipes of greater diameter should not be cut, as apart from the difficulty in cutting, the pressure of the water would probably be too great for any improvised method to stopping to be effective. When a building is badly damaged, the electric lighting wires are liable to be fractured and become tangled; the main supply fuses are likely to have blown, and the whole circuit may be dead. It is an essential precaution however, to find and turn off the main switch; if that is not possible, all electric wires should be treated as alive until it is certain that they are dead. One way of ensuring this is to cut the wire with an axe with an insulated handle. If the supply is alive the cutting of the wires will blow the fuse. Sparks may be caused in the process, but so long as these do not set fire to the debris of cause escaping gas to explode no harm will result. The last paragraph applied particularly to the internal wiring of premises and not the underground mains which run under the pavement or the service cables connected to them. These cables can be identified by virtue of the fact that they have been buried in the ground and are usually armoured and/or covered with weatherproof serving. These cables should be dealt with in the same way as the larger water pipes i.e., the tunnel should be driven over or under them pending the arrival of a representative of the electricity supply undertaking.

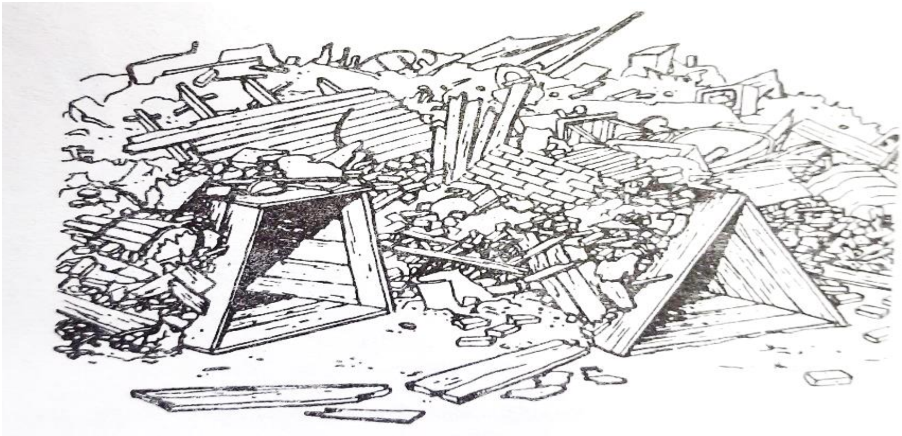
19**. Employment of Workforce**-Because of the restricted size of a debris tunnel, it is not usually possible for more than one man at a time to work at the head, and as this man will be working under extremely difficult and dangerous conditions, he should be relieved at frequent intervals. The Leader should see that only reliable, fit men are allowed to work at any distance inside a debris tunnel. Usually small, tough, wiry men are more suited for the work than big powerful men, whose size is itself a disadvantage. When too many men are employed on a debris tunnelling operation, they tend to get into one another's way, especially in the darkness. It is a good plan, therefore, to employ only half a Party on any one tunnel, and to give each man in the half Party, if he is suitable, a turn of half an hour working at the face. If rapid progress is to be made and men are not to be completely exhausted, a strict rota must be worked. It is a wrong practice to allow a man to work at the face until he asks to be relieved, because he is likely, in his enthusiasm, to work until he collapses and will then of no use for further work. Short periods of very intensive effort taken by men in regular turn is the right method to employ. The rest of the men in the half Party should be kept in continued support of the man working at the face-clearing away debris that he has removed; passing him tools, timber for struts, etc. If it is at all possible it is better and quicker to have two half Parties each approaching a casualty from different directions, than to have the whole Party working at only one debris tunnel. If then, one tunnel runs into very considerable obstruction and difficulty, it can be abandoned and effort concentrated on the other. Whilst debris tunnelling is in progress, unauthorised talking or shouting must be avoided, as the giving and receiving of proper instructions and directions is not only of great importance but also may be a matter of life and death. No movement of any kind should be allowed on top of debris beneath which men are working, and a strict watch should be kept for any signs of the debris sliding or of walls collapsing or any other happenings that may endanger the lives of the Rescue Party of further injure or mutilate the people trapped.

20. **Timbering and Lining Tunnels**-The recommended method for constructing a debris tunnel is by using frames and fore poling Frames are the primary supporting elements of the tunnel They should be prefabricated outside the tunnel and assembled in position as the work progresses. Fore poling is the use of planks or boards driven between the collar and crown bar of one frame and extending beyond the next frame into the debris. The crown bar is the horizontal piece connecting the tops of the two vertical struts of each frame. Two-inch (5 centimetres) spacer blocks are attached at each end of the crown har, a horizontal piece (the collar), parallel with the crown bar, is attached to the spacer blocks, thus leaving a 2-inch (5 centimetres) space between collar and crown bar. The first three frames of a debris tunnel are permanent frames; thereafter, at debris is cleared, temporary frames support the fore poles until permanent frames are put into place. Material for timbering and lining debris tunnels can usually be found in the wreckage. To start a tunnel using the fore pole method; three frames are con structed. The first frame does not require a collar or spacer blocks at the top, not do any of the temporary frames. The second and third frames, and all other permanent frames in the tunnel, require spacer block and a collar. Frame 3 is set first against a cleared vertical face of debris and then frames 2 and 1 are placed next at approximately 3 feet (90 centimetres) intervals back from the cleared vertical face



of debris, and are solidly braced Frame 1 should be diagonally braced to stakes driver solidly into the about 2 to 3 feet (60 to 90 centimetres) in front of each strut. After the frames are in place, the top from frame 1 to frame 3 is covered with long pieces of lumber, such as floor joists, roofing, or flooring. Beyond frame 3. fore poles need to be long enough to overlap only from one frame to the next. The sides are lined in the same manner as the roof of the tunnel, driving boards between the frame struts and the rabble. To ensure stability of the tunnel thus far completed, debris is piled against the sides and over the top. When completed, the frames should be completely covered, with the exception of the first frame and the diagonal braces When debris is removed about 2 feet (60 centimetres) beyond the third frame the load on the fore poles may make it necessary to construct a temporary frame firmly wedged under them until enough debris is removed to permit construction of a permanent frame. The temporary frame should be removed after the frame is properly braced and lined. This procedure is repeated until the tunnel is completed. Usually, the debris of a demolished structure includes small rubble and dust which will tend to trickle through the timbering. At first this may not seem important, but the escape of this material in quantity may disturb the mass of debris, causing internal movement. Therefore, a tunnel through small loose debris should be boarded as closely as possible.

21. Rectangular framing has certain disadvantages in debris tunnelling. Since frames are not rigid, unbalanced side pressures may cause them to collapse. In some instances, short debris tunnels with small

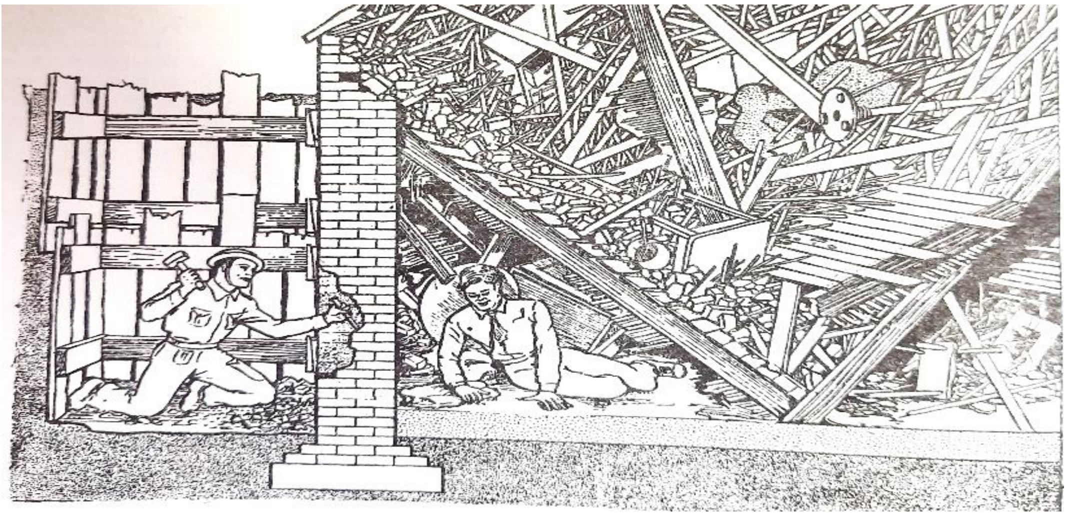


cross sections may be constructed in the form of a closed triangle, using heavy planks keyed together at the ends. Regardless of the method used, the strutting or lining in a debris tunnel must be as rigid wedged as possible. Rigidity and wedging will keep the lining in position and prevent it from being broken by the impact of shifting or moving debris.

22. **Removing Spoil during Debris Tunnelling**-Rubble, broken timber etc. extricated by the work at the head of the debris tunnel must all be removed by the rest of the party and dumped clear of the work in a continuous process. The best plan is to form a human chain so that materials, removed by the worker at the head, can be quickly passed back from hand to hand until they are clear of the tunnel. As lar as possible, the operation should be so organised that the worker at the head can quickly receive all necessary tools and timbers, and have all the debris he has removed quickly cleared out of his way without having to leave his place.

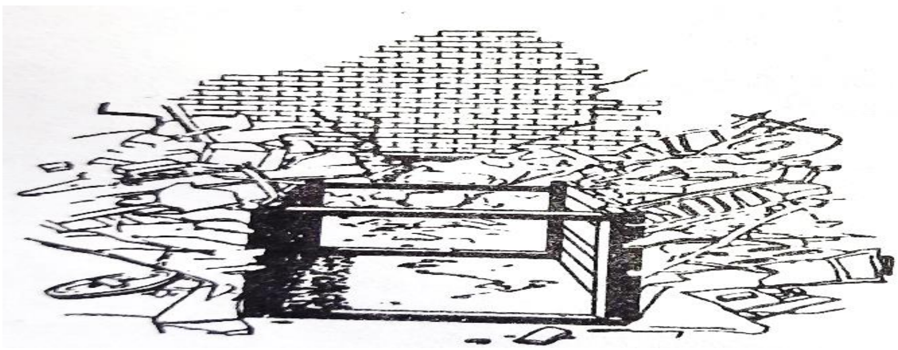
23. **Digging Shafts**-In some circumstances, especially where large masses of debris are concerned, the best way to reach persons trapped in a basement is to sink a shaft or hole, down to basement level, in the ground alongside the building, and then to tunnel from the bottom of this hole in a horizontal direction unit the basement is reached, thus avoiding the danger and difficulty of cutting through debris. As much of the debris as possible should be removed first

to enable the shaft to be sunk close to the building. This work should not present any peculiar difficulties to men experienced in excavation. For those without this experience, the most important thing to remember is that even though the ground may appear sound and solid, the sides of the hole must always be supported by timbering Rough and improvised material for this purpose can generally be obtained on the site. Figure below shows a typical method of timbering a hole or shaft. The timbers used should be heavy rather than light and must be wedged into position as tightly as possible. When a shaft or burrow is to be driven in the earth alongside a building the spot chosen should, if possible be one where there are no service pipes or other obstructions. Because of the presence of such obstacle it is best not to sink a shaft in the highway as it is likely to be a slow and troublesome job. Watch must also be kept for subsoil water, as this may flood the works, and the basement, too, if the wall is broken through.



Digging Shafts

24. **Trenching**-Frequently an open trench can be completed more quickly than a tunnel if debris is not piled too high. Trenching and tunnelling operations may sometimes be combined, with a trench extended into the debris until a tunnel becomes more practical. To trench through debris, start by removing the larger pieces of timber, stones, or other objects from the face of the pile nearest the objective.



Then clear a way through the debris by shovelling and other hand methods, removing the minimum amount of material necessary to provide a safe passageway. Progress is governed by the type of debris through which the trench is made. Trenching may be dangerous. If a trench collapses, the worker has little chance of avoiding injury. To avoid collapse or dangerous movement of the sides of a trench, bracing or some other method of retaining the sides may be required. One satisfactory method of trenching is to drive sufficient sheet piling (usually lumber found at the site) into the ground. Additional support may be provided by horizontal bracing of the sheet piling, using screw of building jacks if available, or wood struts between the two retaining walls as necessary. Material removed from a trench should be piled at some distance from the edge, so it will not fall back into the trench or have to be moved again. The size of the trench will be governed by its purpose and the nature of the debris. Trenching is used to reach a specific point, not for general clearance. A crew may decide to start two or more trenches to a given point simultaneously, since it is not always possible to determine the fastest route.

25**. Handling Casualties in Tunnelling Operations**-Severely injured casualties should be brought out on a stretcher where possible and, if necessary, strapped on by means of the manifold stretcher harness or by a stretcher lashing. The standard webbing bands should be used in preference to lifting the casualty by hand, and as in most cases it is very difficult to determine at first the nature of the casualty s injuries it is safer to assume that they are serious. Slightly injured casualties can be easily brought out through a quite small tunnel by means of a board to which the casualty is lashed, uninjured person should be able to crawl out.

26**. General Precautions during Tunnelling**-The following precautions should be followed:-

(a) Where dust is troublesome, a handkerchief or cloth worn over the nose and mouth will prevent serious inconvenience.

(b) Steel helmets should be worn to avoid minor head and face injuries.

(c) Dust goggles should be worn to save the eyes from dust and grit.

(d) The man working at the face should have a life line attached to his waist, tied with a nonskipping knot so that he can be easily traced if the debris collapses over or behind him.

(e) Debris gloves should be worn, as they save minor hand injuries which may cause: unnecessary delays.

(f) Extra care must be taken, especially in the use of edged tools, on nearing a trapped person.

27. If there is any doubt as to the success of a debris tunnelling operation and in debris tunnelling there is nearly always considerable doubt-alternative methods of reaching the victims should be tried simultaneously. If for instance, a large basement shelter is hit, rescue operations might be attempted simultaneously be one or more debris tunnels and a shaft in the ground outside, always provided sufficient men are available for the work.

CONTROLLED DEMOLITIONS

28 **General**-Some buildings damaged during an air stroke could be dangerous and might constitute a potential source of danger to public. Their presence near the road side might endanger the life and traffic. It would, therefore, be necessary to dismantle these buildings as quickly as possible. This would involve use of explosives in some cases. The use of explosives may be undertaken preferably with the assistance of the Army.

29. **Explosives used for Controlled Demolitions**-The following explosives may be used for controlled demolitions:

(a) **Explosives**

(i) TNT Slab-It is a slab weighing 1 lbs and generally in dimension 4 ½ x 2 ½ x 1 ¾ . It is used
for boring hole in walls or making any other improvised charges.

(ii) **Maslie Explosive-**It is a dough like substance, yellow in colour and can adopt any shape. It is generally available in 4 oz weights with dimensions 3" long x1 ½ " in diameter. It can be used for making improvised charges for demolition.

(iii) **Gun Cotton Slab**-It is a slab weighing 19 oz and is available in size of 6"x3"x1½ ". Its similar to TNT Slab.

(b) **Firing Accessories**

(i) **Safety Fuse**-It is a wire filled with Gun Powder with a diameter of 21". Its rate of burning
is 2 ft per minute.

(ii) **Cordex-** It is similar to Safety Fuze except its rate of burning is 20,000 ft per second; it is white in colour.

(iii) **Primer**-It is used for providing detonation to a TNT Slab and its size is 1.25"x1.35" diameter.

(iv) **Detonator**-It is used for providing detonation to the primer and its size is 1¾ "x .26" diameter.

(c) **Types of Charges**

(i) **Cutting Charge -**It is used for cutting steel, wooden planks or walls.

(ii) **Footing Charge-**It is used for cutting masonry concrete piers.

(iii) **Breaching Charge-**It is used for demolition of reinforced concrete obstacles or walls.

(iv) **Pressure Charge-**It is used for demolition of RC beams and concrete slabs by pressure.

(v) **Shaped Charge-**They are available in various shapes. The most common being behave mark III. It consists of a conical container weighing 5 kgs, with explosive contents of 3 kgs. It is used for making bore holes or demolition of reinforced concrete. It can cut a steel girder 6 to thick

30. **Method of demolition-**There are two methods of demolition:

(a) Systematic demolition of the whole building using explosives or heavy mechanical aids

(b) **Piece Meal Demolition**-By manual labour, removal piece by piece working from top bottom.

31. The method adopted for demolition would depend upon:-

(a) Accessibility.

(b) Degree of urgency

(c) Working space available.

(d) Type of building-extent of damage

32. Safety Measures. Even though it takes more time and labour the piece meal system of elementary demolition, is the safest. The following safety measures should be adopted while carrying out elementary demolitions:

(a) Ensure all casualties have been cleared from the building or structure.

(b) Cordon off the area so that no one comes in the way.

(c) Any fixtures of the building that can be quickly removed should be stacked clear of the site.

(d) The brick and rubble are dropped inside the building and collected at intervals and removed (This would reduce the dust to some extent).

(e) When ropes are used, ensure that timber packing is given wherever necessary to prevent the ropes from cutting/chaffing.

(f) When pulling down, try to do the work in small lots, than to pull down a big piece.

(g) Ensure that the falling pieces do not fall on the members pulling it.

(h) Use a steel wire rope in preference to a fibre rope.

33. **Demolition by Heavy Mechanical Equipment**- It will be found necessary to use Heavy Mechanical Equipment in Rescue Work where the devastation due to enemy air raids is so concentrate and speed in Rescue Work becomes paramount. Of course this will have to be in support of normal Rescue Operations. The purposes where this could be used to greater advantages are as follows:

(a) Quick removal of heavy debris

(b) Lift heavy blocks of brick or concrete and create access to voids:

(c) Clear important road blocks of debris;

(d) Take the weight of collapsed floors and heavy steel work and make Rescue in confined places less hazardous, and thereby speed up exploration and extrication of casualties:

(e) Haul up twisted and heavy steel work which obstructs rescue operations:

(f) Assist in the removal of persons injured or trapped. At this stage mainly heavy plant is needed, particularly mobile cranes with sufficient length of boom or jib to reach for long distances over the wreckage of building.

(g) Enable CD vehicles and fire appliances to reach areas where major rescue and other problems exist and require urgent operational action.

(h) Take certain safety measures i.e., pull down unsafe structures.

(i) Help to restore communications and afford access for the repair of damaged mains and pipes beneath the streets and pavements by clearing them.

34. Heavy Mechanical Equipment that could be used for demolition is mentioned below: -

(a) Bull-dozers and Angle dozers	Dozing heavy debris.
(b) RB-19 Mechanical Jib or Mobile Cranes.	For extricating casualties where it is impossible otherwise.
(c) Dragline and shovel.	To load vehicles with debris that it can be taken away from the side.
(d) Compressors	For breaking heavy concrete.
(e) Winches	For Pulling down structures.

35. **Demolition by Hauling Gear/Steel Cables**-In many incidents it may be found that the explosion has so disrupted buildings that many parts, walls, chimneys, stanchions and floors are cut off or left in a state of great instability, with likelihood of possible further collapse, risk to life and damage to adjacent property. These conditions call for prompt and skilled action, involving the controlled direction of the fall of the unsafe parts, by the use of slowly applied power exerted through wire cables.

DEBRIS CLEARANCE

36. **General**-The removal of debris resulting from a collapsed building falls under two categories in rescue operations apart from the obvious debris that is on or near the casualty.

(a) Selected debris removal, removing debris from a specified part of the site where casualties are known or suspected.

(b) General debris clearance of the whole site in order to recover casualties, or bodies, whose exact whereabouts are unknown.

37. Debris which may be covering victims must not be walked over indiscriminately nor disturbed in any way until a plan of action has been decided upon. It is far from easy to recognise a body in a pile of debris, especially when large quantities of mortar and dust are present. Where it is essential to clear debris the top downward helpers should be stationed in

such a position that they can pass timbers and other pieces of debris to one another without having to climb over the debris.

38 **Selected Debris Removal**-Immediately the known casualties have been dealt with, leaders of teams must try to find any persons still on accounted for. The most likely position of casualties may be ascertained by collecting information, by deduction, or by a calling and listening period. The behaviour of floors is a good guide to follow. Try to find what happened to the particular floor on which a missing person was supposed to have been, as this will generally produce a clue to their position. A few minutes thought at the beginning of the job may save hours of work later. Always proceed on the assumption that a trapped casualty is alive, therefore:-

(a) Speed is necessary.
(b) Care is essential in moving even the smallest piece of material
(c) Once located, an endeavour should be made to keep the casualty informed of what is being done for him.

39. Wherever possible a natural way through the debris should be found. If it becomes necessary to force a way through, then great care must be taken. Timber which is not comparatively free must not be removed or pulled out of the debris by force as it may be protecting a casualty, or supporting a section of the debris. When getting close to a casualty remove the debris by hand rather than by the use of tools. In this case gloves should be worn, if available, to protect the hands. If it is necessary to use a shovel do so with care. For removing dust and small rubble in confined spaces, or when working close to a casualty, a small fireside shovel is very suitable. If available pointed-nosed shovels, with short handles, prove best when dealing with mixed debris where there is no level bottom for the shovels to work on. Ordinary square-nosed shovels are used in the more straightforward clearance when there is no restriction of room or movement, and a level foundation can be found to work on Only persons skilled in rescue work should use picks of debris, and even then, only with the greatest care.

40. **General Debris Clearance**-Should there still be persons missing and their exact location in the debris is unknown, then systematic general debris clearance must be commenced. This should not be confused with general debris clearance to clear a site, a straightforward job usually carried out a later stage by mechanised means. General debris clearance as a rescue operation demands considerable expedition as well as care to avoid further injury to casualties and mutilation of bodies. Debris must be removed clear of the operations and segregated, timber on one pile, bricks on another and so on. The practice of moving debris from one part of the site and dumping it on to unsearched debris must be avoided.

41. **Methods of Debris Removal**-There are two methods of removing debris: -

(a) **Debris Bins**-The actual removal of debris may be done in various ways. Debris can be removed by hand or by using receptacles found on the site, e.g. dust bins, buckets and man handling them to a selected spot where the debris is to be dumped. Bins or buckets are much better than baskets as they enable small debris and dust to be removed and can be used for getting water out of flooded basements in which casualties are trapped. One man can carry a bin-normally on his shoulder-but he needs help to raise or lower it.

(b) **Human Chain**-When removing debris in confined space or over obstacles it is best to form a human chain. The bins, buckets or whatever are being used are passed from man to man and emptied at points known to be clear of casualties.

42. **Precautions in Debris Handling**-Shovels, picks, and other standard hand tools are used in debris removal only when the location of the casualty is definitely known and all other casualties have been accounted for. Recognizing a body in debris is sometimes difficult. Therefore, tools, especially picks (if used at 11). should be used with great care to avoid further injury to the victim. Debris close to a casualty's known or expected location should be removed only by hand. Rescue personnel handling debris should wear gloves to prevent minor injuries Debris should be removed to areas clear of the damaged building in baskets, buckets and wheelbarrows. Only when it is reasonably certain that rubble or portions of buildings to be removed do not conceal other casualties, should cranes, power shovels. and bulldozers be used for debris clearance to gain access to casually locations, or to prevent further damage or collapse which may hinder rescue operations. Such heavy equipment should be under the operational direction of the rescue personnel. If it proves necessary to pile debris in the streets, rescuers should remember to avoid blocking traffic. All debris that has been moved should be marked. Rescue Personnel, with the help of the police, must exercise constant vigilance to prevent disorganized and unsupervised groups from digging at random in the area. Workers should not climb over piles of debris unnecessarily, the disturbance may cause further collapse, making the rescue problems more difficult and decreasing a casualty's chance of survival. As debris is removed, rescuers should provide accessary support or stabilize the debris to prevent dangerous movement and further collapse.

RESCUE FROM BASEMENTS

43. **General**-Except in certain areas, most old domestic property and nearly all large buildings have basements or cellars sunk party or entirely below ground level. In domestic property the normal way of access to such a basement is by a small staircase situated immediately below the main staircase of the house. An important point to note about domestic basements is that most of them are provided with some form of window, hatch or pavement light, either in the pavement or in the court around the house and immediately below one of the windows of the ground floor. In large buildings built alongside pavements, basements usually extend for a distance of 2 or 3 yards under the adjoining pavement and in this portion are usually found the coal chutes, pavement lights and so on, which afford ingress to be basement. When there is no pavement light or coal chute, access to a basement which extends under the pavement can usually be obtained by lifting the paving flags and cutting through the basement roof Care must be taken, however, not to cut too large a hole, as this may cause the collapse of the brick arch It is equally necessary to avoid cutting through service pipes and cables. It is of the utmost importance that Rescue Section workers should be familiar with the various forms of construction used in basements, for many basements may be specially strengthened for use as a place of refuse. Rescue Parties are frequently called upon to extricate trapped persons from basements of demolished buildings either when the basement ceiling has collapsed or when (probably as a result of strengthening) it has stood up to the debris load. The first task is to try to discover the layout and extent of the basement, the location of the entrance and emergency exit, and whether or not there are basements in the adjoining buildings. Steps should also be taken, if possible, to determine from an examination of the outside whether or not the ceiling collapsed and if so, in what way.

44. **Forms of Collapse-**It is unusual for the outside walls of a basement to be damaged by blast, principally because they are below ground level and are therefore protected from the blast effects and because they are normally of greater thickness than the walls above ground. If, however, earth shock has formed one of the effects of an explosion, the basement walls may suffer damage. The outer walls of basements are unlikely to be less than 14 inch thick even in small buildings they may have a thickness of 3 ft. or more. Party walls that separate one basement from another are usually thinner than the outer walls of basements. In unframed buildings, the ceiling over the basement is more likely to be damaged than the walls because it receives the full load of debris from the upper floors. This overloading may result in a partial or complete collapse of the ceiling, unless it has been suitably strengthened to withstand the probable load. Experience shows that when a basement ceiling collapses due to the weight and impact of debris form above: -

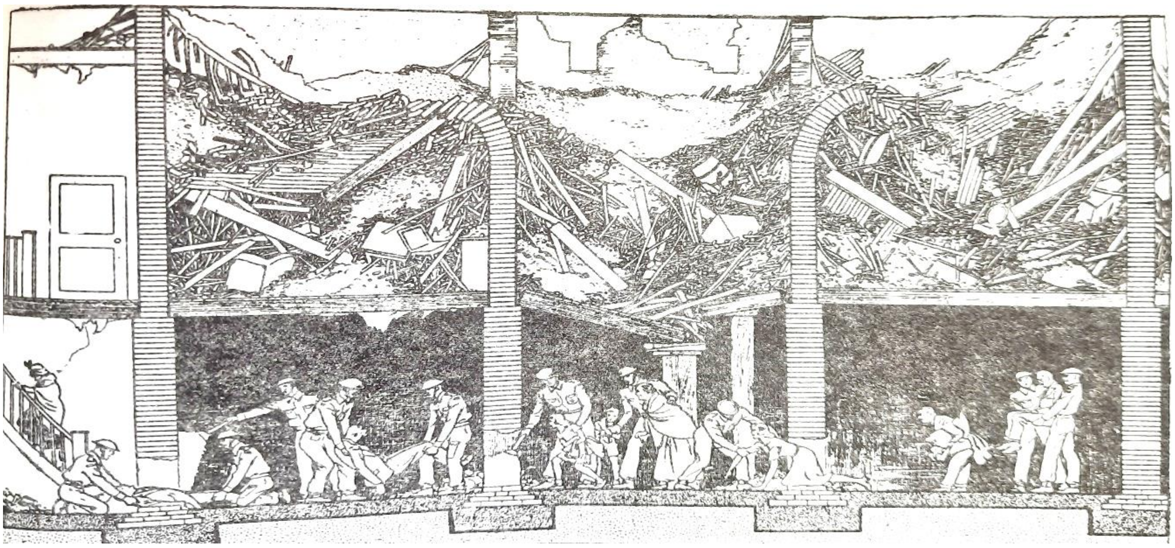
(a) The ceiling joists, while tending to break in the middle, may remain attached to the walls at their extremities and so form a "V" shaped collapse with voids against the walls at either end.

(b) If the main weight of debris comes at one end of the ceiling joists, however, the joists may be broken off near the wall at this end and collapse to form only one lean-to against the opposite wall of the basement. In considering where lean-tos are likely to be formed when the joists over a basement have collapsed, it should be remembered that they are practically always laid the narrowest width of the room so that lean-tos are most likely to be against the longest side of the room. The formation of void, mentioned above is of particular importance because they may protect persons in the basement from the main load of the debris and so enable them to be recovered alive. Voids can also be used to gain access to other parts of the basement or to basements of adjoining buildings.

45. **Reconnaissance-**The first essential is to try and discover the lay-out and extent of the basement, the location of the entrance (or entrances) and emergency exits and whether or not there are basements in adjoining premises. Steps should also be taken to try and determine by examination whether or not the floor above the basement has collapsed.

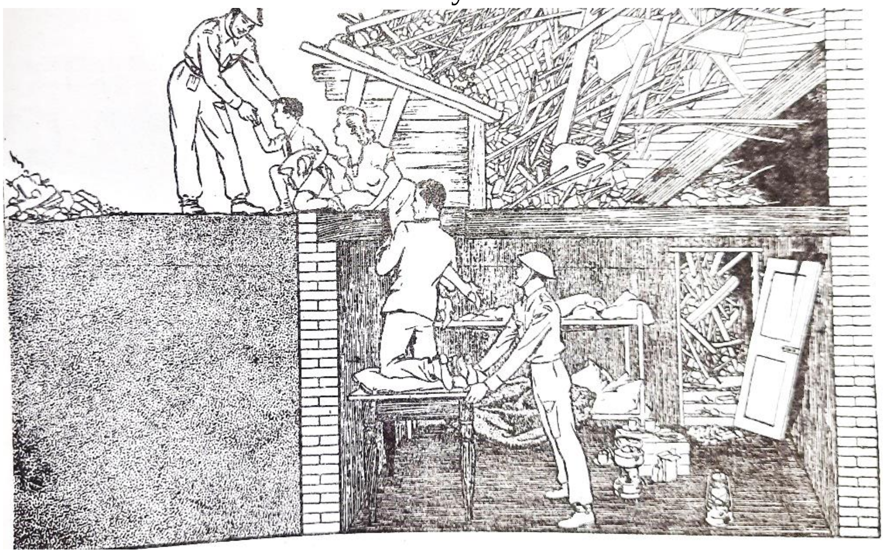
46. **Entrance to Basement**-The following methods may be used to enter the basement:

(a) By breaking through the wall from a adjoining basement which has not been so severely damaged. To increase the probability of reaching quickly a void which may have been formed by the collapse of the basement ceiling, it is better to break through the wall at a point near the corner of the basement. Consideration must, of course, be paid to the construction and thick ness of the wall.



Rescue from basement by breaking through the divisions wall from accessible adjoining basement. Where applicable, this is usually a fairly safe and expeditious method. From the diagram access is gained by cutting walls and debris tunnels until A, B and C are successively reached.

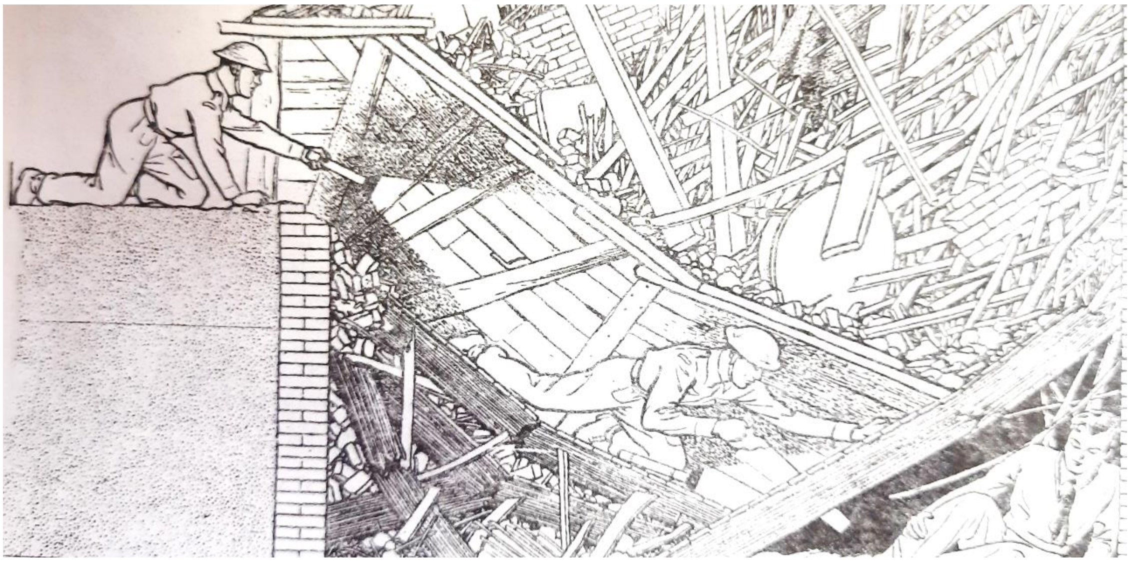
(b) A manhole or emergency exit leading from the basement outside may be cleared of debris and an entrance effected in this way.



Rescue from a basement where the celling remains substantially unbroken. Debris is cleared back, or a tunnel cut through debris until part of floor is undercovering. Through this, a hole is cut providing access to basements.

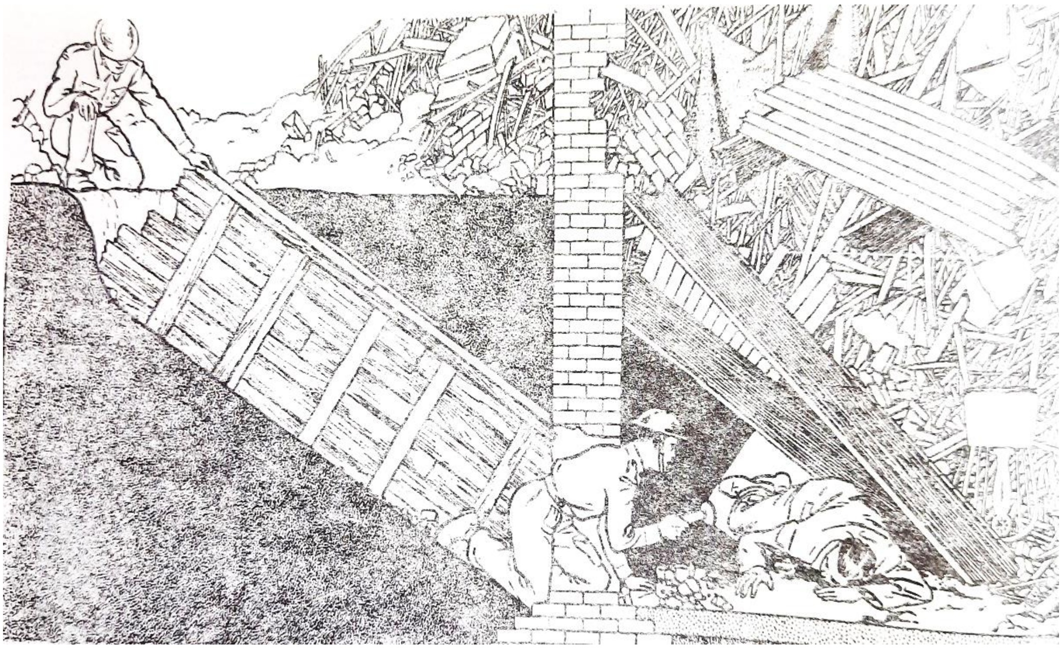
(c) Where the ground floor has not collapsed a small area may be cleared either by tunnelling to the spot or by removing the debris from the ride and cutting a hole in the floor to give access into the basement.

(d) Where the basement ceiling has completely collapsed, a tunnel or hole may be drives from the edge of the debris downwards to the floor of the basement. From this point exploration of the basement can be continued by working round the walls to all available voids.



Rescue from collapsed basement by means of a debris tunnel. This method may be possible when it is difficult or impossible to excavate on the outside of the basement wait.

(e) In some circumstances it may be necessary to construct a ramp from ground level to the basement wall, and then to cut through the wall and form a debris crawl way in order to



Rescue form collapsed basement by means of a ramp.

link voids to affect the rescue of the casualty. This can be done by cutting a lane through the debris at ground level, and then digging out the ramp to basement floor level. It should always be borne in mind of the sides of the debris lane and the ramp may need supports to make them safe from collapse. Rough and improvised material for this purpose can generally be obtained on the site. Any timbering used should be heavy and firmly wedged into position. Watch must also be kept for subsoil water, and where basements have been "tanked" with waterproofing material this should only be cut through above the level of the water table otherwise the basement may become flooded. Care must also be taken to ensure that no service pipes are fractured. If a lean-to is formed by the collapse of the ground floor against one wall of a basement, there is likely (for reasons already explained) to be another lean-to against the opposite wall and it may be necessary to cat a crawl way, and make it safe against collapse by adequate timbering etc., through the debris from the first void towards the opposite wall in an endeavour to reach the second void.

47. **The Signalling**-Though the line signals can be arranged by the members on the spot, it would be better if all the rescue parties follow some standard signals. The following are the standard signals followed by the Fire Brigade Members when they work in darkness and these signals may also be conveniently adopted by the CD Rescue Parties

Signals	Meaning when given by the wearer	Meaning when given by the mate outside
(a) Pull	I am all right	Are you all right
(b) Pulls	Pay out more line.	I am paying out more line
(c) Pulls-Paule-2 pulls	Stop paying out or lowering	I am casing paying or lowering possible
(d) Pulls	Haul up or haul in slack line	1 am banding up or I am hauling in slack line
(e) Repeated Sharp Pulls	Danger-help me out.	Danger-I am hauling up as quickly as possible.

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CHAPTER 15

RESCUE FROM HEIGHTS

1. **Introduction-**

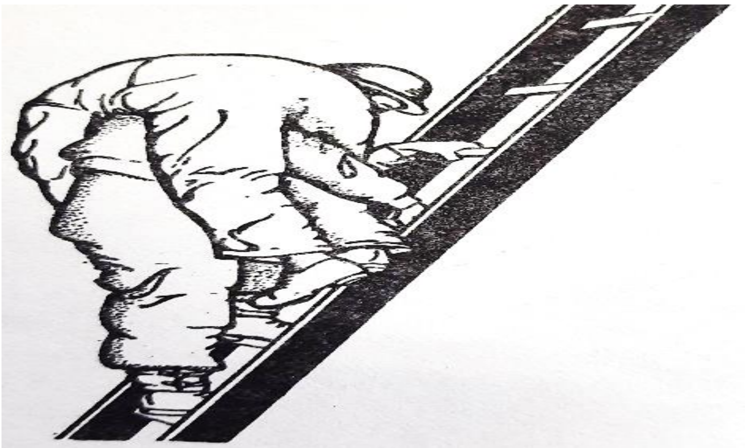
With the emergence of latest technique of building construction more and more multi-storeyed high rise complexes have appeared in most of the modern cities. Notwithstanding. the fact that they ultimately turn out to be space savers, they pose tremendous amount of strain and difficulties to rescuers during the rescue operations.

2. Casualties are likely to be marooned above the ground floor level either because of blockage of escape route or trapped due to the damage to buildings. Rescue of such trapped individuals requires perfect skill. Quick action and safe methods by which the trapped persons can be rescued. These drills adopted by rescue party members is known as rescue from heights.

RESCUE BY LADDER

3. **Fireman's Lift-**

If it is vital to remove a casualty to safety he must be removed regardless of his injuries and he can be brought down a ladder by means of the Fireman's Lift. In pitching the ladder for this operation, the head of it should extend about 5 feet above the sill or parapet, and if practicable, be properly secured. The ladder should be placed at the side of the window or opening, normally on the left-hand side when viewed from outside. Where the window is narrow the ladder should rest on the wall and not on the sill so that the maximum working space is left. When descending the ladder, the rescuer's head should be kept well forward allowing the casualty's body to rest squarely on the shoulders. For reasons of safety when a casualty is being brought down a ladder by the fireman's lift, the rescuer should grasp the rungs of the ladder, normally using both hands when the casualty can be easily balanced. On occasions, with a difficult carry, it may be necessary to hold the casualty with one hand, leaving the other free for grasping the rungs. Descent should never be hurried but should be slow and steady, and the arms and legs working smoothly. This method should only be used by rescuers having undergone advanced training in rescue operations.



Bringing down by fireman’s lift.

4. **Leaning Ladder:-**

(a) **Suitability**- This method is suitable where a casualty has to be removed through a window or an opening on the upper floor, (say, first floor) and where the condition of the wall is such that ladder can be made to rest against it

(b) **Manpower**-Six persons.

(c) **Equipment**

(i) Extension ladder 35’ (10.30M)	1
(ii) Snatch block/Single sheave pulley block	4
(iii) 40 length 1 ½ " (12M 38.10mm) fibre lashing ropes.	4
(iv) 100' length 3"/2 ½ " (30M 76.20mm) fibre rope.	1
(v) String of Hemp for mousing	1
(vi) Stretcher	1
(vii) Blanket	1
(viii) Stretcher Sling	1
(ix) Small Iron Pickets	2
(x) Sash Cords 15' x 1' (4.50M 25.40mm).	3

(d) **Operation**-In this method the ladder rests against the wall with the top of the ladder at a

sufficient height above the window to give enough clearance so that a stretcher with casualty lashed to it can be cleared. Keep the ladder on the ground with the heels of the ladder towards the building Tie a snatch block or a single-sheave pulley block to the second or third rung of the top of the ladder by means of a lashing rope. Commence lashing by making a clove hitch over the left string of the ladder-marry the ends-take four clockwise horizontal turns over both the strings-take two frapping turns over the horizontal turns-tale two turns over the rung of the ladder above the horizontal turns-insert the hook of the pulley block-diagonally cross over the hook-take two turns again over the same rung-then take two turns over the horizontal turns, and finish with a clove hitch diagonally opposite over the right string and lastly complete by mousing the hook. A 3”/2 ½ " (76.20mm/63 50mm) pe used as a lowering line, is passed through the pulley. The ladder is then raised by four men to the vertical position and extended, if necessary, to the required height, and rests against the wall. Care should be taken to keep the heels of the ladder on firm ground or secured to pickets driven in the ground by the side of the heels, or the two men there should hold it to prevent from slipping. The upper end of the lowering line is fastened to the stretcher sling and the other end is passed below the lowest rung of the ladder and held by two persons. Two guide ropes are attached to the stretcher handles away from the wall before lowering it. The stretcher with the casualty, properly blanketed and secured, is allowed to be lowered by two rescuers on the upper floor. The two persons at the base of the ladder pay out the lowering line gradually from below, allowing the stretcher to come down. Guide ropes, held by two persons, are used to keep the casualty away from the wall. As the stretcher nears the ground, the two persons who were holding the guide ropes approach the stretcher, place it on the ground and remove it from the site after unfastening the stretcher sling. In place of a stretcher, a chair knot can also be used depending upon the condition of the casualty.

(e) **Special Instructions**

(i) Instead of two persons holding the guide ropes to keep the stretcher away from the building, only one person may be employed to hold both the guide ropes, if it becomes necessary to curtail the required manpower.

(ii) In place of the two persons at the base of the ladder, as at present, only one person may be engaged to pay out the lowering rope, and the second person required to hold the lowering rope behind the ladder will not be necessary there, as the rope is being paid on from under the bottom rung of the ladder which provides a braking action. This may become necessary where the required manpower has to be further curtailed.

Note-According to circumstances equipment and manpower requirement may vary.

5**. Sliding Stretcher on one Ladder**

(a) **Suitability**-This method is suitable where the height of a window sill, or an inclined position,
permits. By this method, the casualty is brought down inclined position.

(b) **Manpower**-Five persons.

(c) **Equipment**

(i) 35’ (10.50M) Extension ladder.	-	1
(ii) Lashing/1 ½ "-40ft. (38.10mm-12M)	-	3
(iii) Pick handles	-	2
(iv) Blanket	-	1
(v) Stretcher	-	1
(vi) Sash Cords/15 ft. -1" (4.50m-25.4mm)	-	4
(vii) Pickets	-	2

(d) **Operations**-Two rescuers reach the casualty through the window, or the opening by using the ladder after its heels are secured to the pickets, or placed into holes dug into the ground. They carry with them the stretcher, blanket, lashings and pick handles, while two hold the ladder against the wall. The two rescuers on the upper floor place the casualty on the stretcher, blanket it and secure it in the normal manner. Then they fasten a 40ft. (12M) lashing by bowline knots to each of the stretcher "Ds" or making bowlines passing the ropes in between the stretcher canvas and the stretcher bar. Then make fast by applying one or two half hitches on the pick handles. The rest of the rope is now available as guide ropes on either side. A pick handle at each end of the stretcher is essential, the one at the foot to keep the lower traverse bar from fouling any part of the ladder and thereby tending to close the stretcher. The head one helps the stretcher to slide smoothly on the strings of the ladder. Pick handles must be secured with equal projection on both sides of the stretcher. One rescuer gets up the ladder and is now at the window sill to receive the stretcher, foot end first. One of the rescuers at the base of the ladder applies his feet, and the other gets under the ladder and braces it from underneath. The rescuer on the ladder holds the handles of the stretcher and slides it down the ladder, slowly and gently, easing it over any obstructions, while the top rescuers help to get over such obstructions by lifting on the restraining ropes i.e., the 2 guide ropes when necessary. Finally, the two rescuers on the ground move around the sides of the ladder, when the stretcher arrives within the reach from the ground, remove the restraining ropes and pick-handles and carry the stretcher away. The top rescuers come down the ladder and assist to lower the ladder, coil the ropes and take them away.

(e) **Special Instructions**-If the required manpower of five persons is not available, the number can be reduced by one, and only four persons may be employed, provided the heels of the ladder are properly anchored-not shown in the sketch.

6. **Sliding a Stretcher on two Ladders**

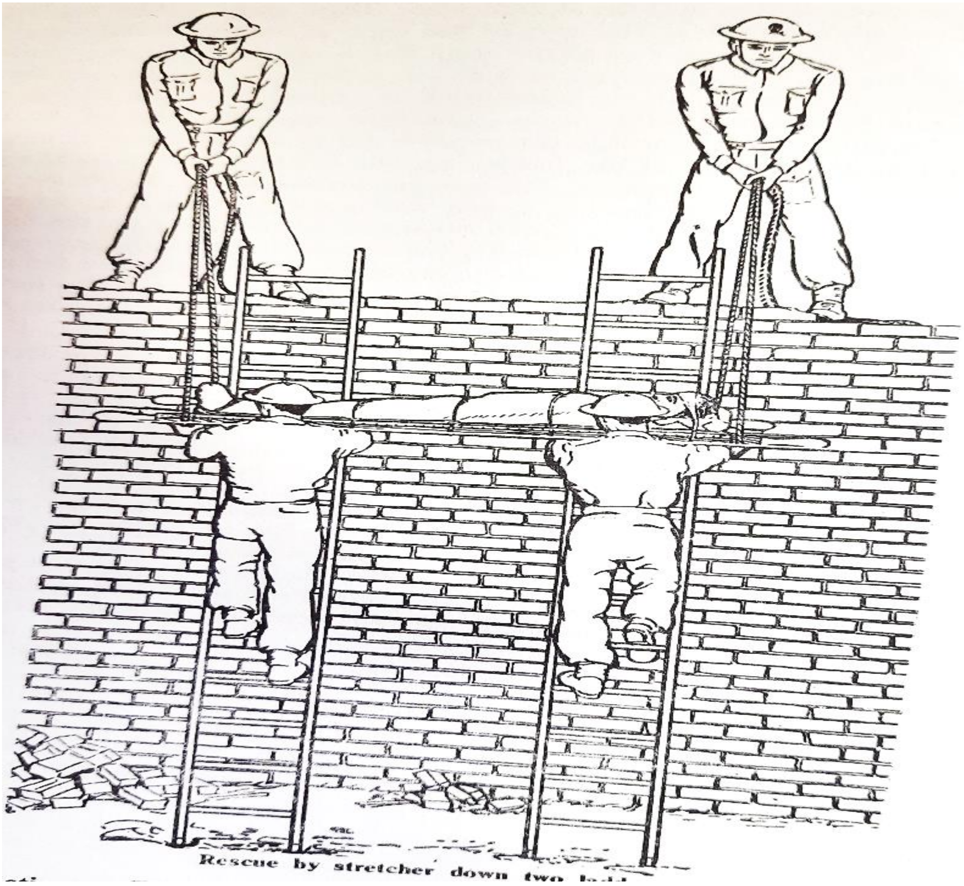
(a) **Suitability**-This method is also suitable where the height of a window, or an opening permit. This is however far slower than the other one. But the main advantage, in this case, is that the stretcher is kept horizontal by two men descending on two ladders, and helped by two men from above with the help of ropes, and the casualty comes down gently. This method will be more appropriate, where the casualty has to be brought down horizontally, and the condition near the base of the wall does not permit the use of Ladder Hinge Method.

(b) **Manpower**-Six persons.

(c) **Equipment**

(i) 20 ft or 15 ft (6 M or 4.50M) long ladder, if sufficient.	-	2
or		
35 (10.50M) Extension ladder (separated to serve as 2 ladders).	-	1
(ii) Lashing 1 ½ "-40ft (38.10MM-12M)	-	5
(iii) Stretcher	-	1
(iv) Blanket	-	1
(v) Pickets	-	4
(vi) Sash Cords 15-1 (4.50M-25.4MM)	-	4

(d) **Operation**-The six rescuers form two groups and place two ladders against the wall, side by side so that the "Ds" of the stretcher would be slightly beyond the outer strings of the two ladders. The heels of the ladder would be secured to the pickets or placed into holes dug into the ground. Two rescuers go up the ladder with stretcher blanket and three 40 ft (12M) lashings and approach the casualty. Tie the casualty to the stretcher in the normal manner, and secure the ropes to the stretcher handles, as for one ladder method. Two other rescuers mount the ladders, place their arms beneath the stretcher and hold to the strings of their ladder and descend slowly rung by rung keeping time with their feet nearer to the other person, while the men above take the weight of the stretcher, by holding both ropes together in both hands and paying out hand over hand until the casualty is lowered. As the casualty is lowered, the stretcher is received by the remaining two rescuers, holding the ladders from underneath, and carried away from the site.



Rescue by stretcher down two ladders.

(e) **Special Instructions**-The required manpower of six men, if not available, can be curtailed to four men, but the heels of both the ladders must be properly anchored.

7. **Ladder hinge Method**

(a) **Suitability**-This method is suitable where a ladder can be brought to the site, but it cannot be rested against the wall as it may be damaged and will not take the thrust of the ladder But the ladder can be employed by keeping it vertical.

(b) **Manpower**-Four persons.

(c) **Equipment**

(i) 20 (6M) or 15 (4.50M) long ladder, if sufficient or extension ladder 35 (10.50M) from Depot. - 1
(ii) 40 length, 1 (12M. 38. 10mm) fibre lashing ropes. - 3
(iii) Pick handle - 1
(iv) 15' length. 1 (4.50M, 25.04mm) fibre sash cord. - 3
(v) Stretcher - 1
(vi) Blanket - 1

(d) **Operations-** The ladder is kept vertically against the face of the wall, and held stable by two rescuers at the base by applying their hands and feet. The top of the ladder should be about one foot above the window sill or the parapet of the opening. Before raising the ladder from the ground, a pick handle is tied to the ladder at the top by means of square lashings by using sash cords. The casualty is blanketed and secured to the stretcher in the usual way. The foot-ends of the stretcher are made to rest on the projecting ends of the pick handle already tied at the top of the ladder, and secured by making bowlines, one on each side ensuring to secure it through the stretcher Ds or bar, and that there is enough slack to permit the "hinge" action between the stretcher and the ladder. Lathing ropes are tied to the head. side of the stretcher handles by making bowlines and two half hitches over each handle, to be used as guide ropes by the two rescuers on the top, while lowering the casualty. The casualty is now ready for lowering. The operation is as follows

(i) Two rescuers stand at the foot of the ladder holding the ladder firmly at the sides. As the lowering begins, they move back slowly supporting the sides of the ladder with their hands raised above their head, allowing it to drop at an angle, the foot being held against the base of the wall, which forms the fulcrum point.

(ii) The other two rescuers who are at the rear end of the stretcher pass the casualty through the window, the weight on the two guide ropes and allowing the stretcher to ride out clear of the window.

(iii) Lowering is continued smoothly by under-running it, keeping the stretcher horizontal all the while and until the ladder lies on the ground with the stretcher on top of it.

(iv) The two rescuers then unfasten the stretcher and the guide ropes and remove the casualty from the site.

(e) **Special Instructions**

(i) In case the two rescuers lowering the ladder have to move on uneven ground or over some debris etc. where they are apt to lose control of the ladder and the ladder is likely to swing sideways, then two more guide ropes may be secured to the head of the ladder and held by two extra rescuers, one on either side of the ladder to help in lowering it safely. In these circumstances, two more lashing ropes and two more rescuers will be needed.

(i) In case a pick handle, or an iron spike or a piece of bamboo etc. is not readily and quickly available for securing to ladder, this arrangement may be done away with and instead the ladder has just to be raised by two men and held stable vertically, as usual. without tying the pick-handle to the ladder, before raising it as is done at present. The stretcher handles on the feet side of the casualty are then secured to the ladder on both. sides by making bowlines, using just one sash cord. This can be done quickly by tiny trained man. These bowlines provide the hinging action, and work in the normal way to facilitate lowering of the stretcher. The guide ropes are to be secured to the head side in the usual way. Now, the casualty is ready to be lowered by following the usual procedure.

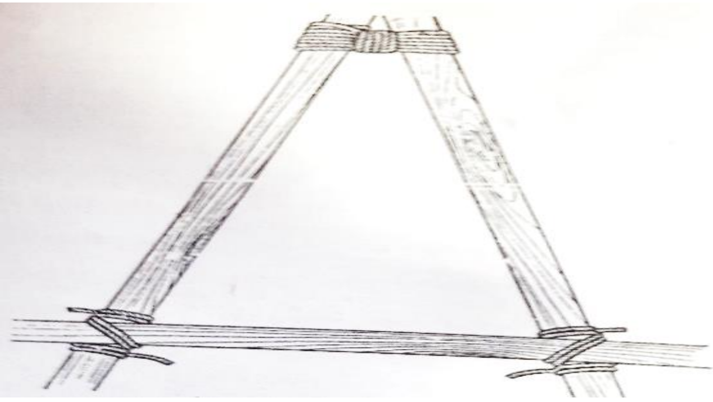
8. **Ladder as a Derrick-Refer** Chapter 11.

9. **Improvised Ladder Hinge-**

If a ladder is not immediately available, the principles of the ladder hinge method can be applied by utilising materials that would normally be available on a damaged site. Two of the most simple methods are as follows:

(a) Obtain a length of sound timber at least 4 in. x 2 in. in section, long enough to reach the required height. At approximately 12 in. above the window sill, lash a cross head approximately 3 ft. long and 3 in. x 2 in. in section at right angles by means of a square lashing. The stretcher should be fastened by taking the centre of a 40 ft. lashing making a clove hitch on either side of the cross head, then taking each end of the rope to the stretcher fastening off by means of a clove hitch on the "Ds".

(b) Obtain two length of sound timber at least 4 in x 2in. section long enough to reach the desired height. Lay them in the position shown in Figure below and fasten the top by means of a round lashing using a personal cord. At approximately 12 in above the window sill opening, a cross head should be fastened by means of a series of clove hitches. The cross head should be a piece of timber 3 ft. long 3 in. x 2 in. in section. Taking the centre of a 40 lashing make a clove hitch on each upright, then another clove hitch diagonally up and taking in both the upright and cross head; a further clove hitch is then made around the upright above the cross head on each side. The ends are then taken to the stretcher and made fast to the "D's" by means of clove hitches.



Improvised ladder hinge

10. The materials available on the site may suggest other variations of this method, and these may he employed provided the overall principles of the ladder hinge method are observed.

RESCUE BY ROPES

11. **Two Point Suspension-**

The two-point method requires a smaller hole through which the casualty lashed to a stretcher can be lowered. The hole need be slightly more than the width of a stretcher. In this method the casualty can only be raised or lowered in a vertical position. The casualty is properly lashed to the stretcher in the normal way. Each end of a 40 feet (12M) lashing is fastened through each 'D' at the head of the stretcher, using bowline knot. The stretcher is carefully passed through the opening or the hole, feet first and lowered gently and without any jerk, the rope being paid out hand over hand. Two men should be ready to receive the stretcher as it reaches them at the lower end. In case the distance of lowering is more, two 40 feet (12M) lashings should be used instead of one

12. **Four Point Suspension Method**-

The four-point method requires a larger opening or hole than the two-point method but has the advantage of lowering or raising the casualty in a horizontal position. The casualty is secured to the stretcher in the normal way. Two to four 40 feet (12M) lashing are tied at each end of the stretcher fastened to the "D's" as in the case of two-point method One person should handle each rope at the four corners of the stretcher and then the stretcher is lowered. gently and without jerks, the four men paying out the ropes hand over hand, in order to keep the stretcher steady Care should be taken to keep the stretcher in a horizontal position. Two men should be ready to receive the casualty as it nears the lower end.

13. **Jib Method**

(a) **Inside the Building-**In some circumstances it is possible to lower a stretcher by means of the 2 in rope and snatch block if a suitable place from which to suspend the block can he found, or safe improvisation can be resorted to.

(b) **Outside the Building**-A jib arm may be positioned to receive the snatch block. If the jib is decided upon, care must be observed both in respect of the jib itself and the structure from which it derives its support. The actual method of supporting or arranging the jib necessarily depends on prevailing conditions. Whenever possible the jib should be erected on the floor above the one from which the rescue has to be made; this avoids crowding and gives better conditions for raising or lowering and for control. Where this is impossible, the jib will have to be placed in position as high as possible on sheer legs or other supports to give sufficient working height, especially if a stretcher has to be passed out and lowered. The jib may be positioned in one of the following ways:

(i) It may be projected over a sill or coping, resting on a piece of timber to spread the load. the jib being kept in position by pads or blocks of timber at either side and the tail end made secure. In this case a window on the floor above that on which the casualty rests would be selected for the positioning of the jib.

(ii) If the jib is to be erected on the top floor of a building it may be possible to pass the jib over the wall-plate, through the rafters, and to lash it securely to the ceiling joists, some method then being adopted for fastening down the tail end of the jib.

(iii) If the jib has to be erected on the same floor as the casualty, it may be arranged to rest on a part of sheer legs erected just inside the window or opening, the feet of the sheers being spread wide enough apart to allow a stretcher to travel through. The feet of the sheers must rest on or be fixed to a sole-plate and prevented from spreading, and the tail end of the jib made secure. As an alternative it might be possible in some cases to lash the jib to the joists of the floor above.

(iv) By erecting a sheer on the floor above that from which the casualty is to be removed, in which case the feet of the sheers need not be too widely, spaced. The feet of the sheers and the tail of the jib must both be made secure as already described.

(v) On concrete floors a deal or floor joist can be placed across the jib tail, and something piled on the tail to counterbalance the weight of the tackle, stretcher and casualty. It is important that the weight on the tail should more than counter-balance all of these.

Notes:-

(i) Two sound joists 4-inch x 2 inch used together or similar sized timber to form the jib are suitable.

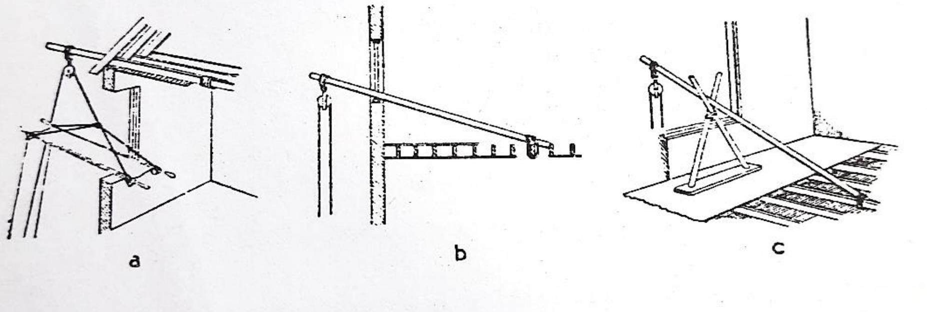
(ii) The butt end should be at the overhang, ie projecting beyond the point on which the jib rests.

(iii) The overhang from the support to the end of the bun should be about 2 feet to 3 feet.

(iv) The snatch block should be securely to the job at a point about 6 inches from the butt by the following method Using the personal cord, commence with a clove hitch on the spar leaving a short end which is then married take two or three round turns around the hunk of the block and the spar, working towards the butt, trap between the hook and the spar, and finish off with a clove hitch on the pale.

(v) Care must always be taken that the 2-inch rope is sufficiently manned, at least three men normally being necessary. In some instances, it might be advisable to ease the strain by taking a round turn horizontally around a suitable object. Always test die rig before attaching the casualty

(vi) Guidelines fastened to the "D's" of the stretcher, at both ends of the side of the stretcher which will be furthest away from the are required to keep the stretcher clear of any projections etc. during its descent. The method of fastening these guide-lines is as already described. A pulley and a two-inch rope can be used in conjunction with a jib for lowering a non-stretcher case by means of a chair knot.



Lowering by snatch block and 2 inch rope. Methods A, B and C.

14. **Two Parallel Rope**:

(a) **Suitability**- This method is suitable for rescuing casualties from greater heights, or when the condition of the walls does not permit resting of ladders against them, or where these cannot be brought to the site, or cannot be worked because of huge piles of rubble, wreckages. craters etc.

(b) **Manpower**-Four persons

(c) **Equipment**

(i) 200'/100' length 3"/2 ½ " ropes	2
(ii) 40 lenght 1 ½" (12M 38. 10 mm) lashing ropes	9(ft. (60 M) long ropes are used)
(iii) Crowbars/Picket	5 (ft. 100' (30M) long ropes are used)
(iv) Stretcher	2
(v) Blanket	1
(vi) String or Hemp for seizin	1
(vi) Hammer	1
(i) 200'/100' length 3"/2 ½ " ropes	1

(d) **Operation**-The two ends of the 3"/2½" (76.20 mm/63.50 mm) ropes are tied to some firm object of the above floor and the lower ends are tied to pickets/hold-fasts at object on the ground. The ropes are tied to the pickets by using round turn and two half hitches, and are kept parallel to each other. The casualty is secured to the stretcher in the usual manner. The foot ends of the stretcher are first placed on the parallel ropes and secured to them by lashing ropes by passing them in between the canvas and the stretcher bar, and bowlines around the handles (or alternatively through the D's), and then applying one or two half hitches over the stretcher handles. The spare ends of the lashing ropes are held by the men on top to prevent stretcher from sliding, and later will be used as guide ropes by two persons on the ground. The stretcher handles at the top are also secured to the parallel ropes as before, by using two lashing ropes which will serve as upper guide ropes. The stretcher is then allowed to slide down the parallel ropes slowly, the speed being controlled by the two men on top.

(e) **Safety Precautions**

(i) The casualty should always be lowered feet first.

(ii) The two parallel ropes must be parallel and equally taut before the weight is applied. The width between the ropes should be just enough to allow the stretcher "D's" to go on either side.

(iii) The object on the upper-floor to which the ropes are tied should be strong enough to take the strain. The pickets should also be strong enough.

(iv) The leader should co-ordinate the work, control and ensure smooth working.

15. **Flying Fox Method**

(a) **Suitability**-One of the methods of rescuing casualties from high buildings is a "Flying Fox". By this method casualties could he brought down under the circumstances which would not permit the use of ladders.

(b) **Manpower**- A team of five men, two on ground and three on the upper floors.

(c) **Equipment**

(i) 3"-200ft. (76 20 mm -60M) rope	1
(ii) Snatch Block	1
(iii) 1 ½ "-40 ft. (38.10mm -12 M) lashings	7
(iv) Crowbars/Pickets	2
(v) Stretcher	1
(vi) Blanket	1
(vii) 1 ½ " -40 ft. (38.10mm- 12M) stretcher lashing	1

(d) **Erection**

(i) The end of a 40 f. (12 M) lashing is dropped from the floor where the casualties are located to the ground. (It may be necessary to join a number of lashings together). The gal panty makes the 3 (76.20 mm) rope fast to the lashing and it is hauled up.

(ii) The 3" (76.20 mm) rope is then adequately secured to either a ceiling joist or point that will allow sufficient space between the rope and the window sill, or the base of the opening on the floor, to allow the stretcher to pass cleanly beneath the rope. Two fest six inches (75 mm) should be regarded as a minimum distance between the rope and the sill. The rope should be made fast some 10 feet (3 M) inside the building so that the snatch block can be placed on the rope before the stretcher loaded with the casualty passes out through the window

(iii) A holdfast, either improvised or pickets, is organised on the ground. The 3" (76.20 mm) rope is then hauled tight and made off on the holdfast with a round turn and two-half hitches.

(iv) The casualty is blanketed and lashed to the stretcher in the usual way, and a stretcher sling applied to it by making a chair knot on a lashing rope. The actual knot of the chair knot is attached to the hook of the snatch block, and the two free ends of the chair knot lashing are used to secure it to the hook. For this purpose, a cross-over lashing is used. taking at least two turns around the hook and the knot, and the lashing finished off with ca reef knot.

(v) Two guide ropes 40 feet (12 M) lashings joined together sufficiently long to cover the full span of the 3" (76.20 mm) rope are then secured to the head and foot of the stretcher through the two "D's" under the stretcher handles by making a bowline. A safety line is attached to the collar of the hook to the of a loaded stretcher while lowering down the 3" (76.20 mm) rope. The rope on foot of the stretcher is then passed out of the window or the opening and taken up by the two men on the ground.

(vi) The stretcher is now lifted up by two men on either side, the third man securing the snatch block over the 3 (76.20 mm) rope, and making sure the pin is in position.

(vii) The lowering operation now commences with the three men on the upper-floor lowering away hand over hand and the two-man ground party taking in the slack in a similar fashion.

(viii) As the stretcher reaches the ground, the chair knot slings and guide-lines are removed from the loaded stretcher. The loaded stretcher is then taken away. In case any more casualties are to be brought down, a new stretcher be attached to the chair knot slings, the two guide-lines secured to the head and the foot of the stretcher and then hauled up with a blanket and lashing for lowering the next casualty. The same procedure will be followed in lowering another casualty.

(e**) Safety Precautions**-There should be no slack in the guide-lines, as these not only control the descent of the stretcher but also act as safety lines. Should the 3" (76.20 mm) rope, chair knot or snatch block carry away, the stretcher can still be supported by the guide/safety lines, but only if the two teams are fully prepared for the sudden additional weight.

RESCUE BY EMERGENCY CHUTE

16. The emergency escape chute has come out as a latest and reliable end to the quest for finding solution to the problem of rescue from high rise buildings. It is a tough water-proof heat resistant cloth tube opened at both ends and fitted with GI pipe/metallic rings/frame and has proved to be an excellent and quick means of evacuation from heights. The equipment has the following major advantages:

(a) Short time of setting up and preparation (3 to 5 minutes).

(b) Control descent.

(c) Shock-proof and safe landing on ground.

(d) Permits multiple descent.

(e) Can be used by trapped individuals from varying heights.

17. **Inclined Chute.**

(a) **Construction**-The inclined chute constructs of a single tube made of water-proof, powerful heat resistant and antistatic electricity fibre. The width of this chute is approximately two meters and the length ranges from 60 ft. to 100 ft.

(b) **Manpower**-Following manpower is required for fixing the chute:

(i) Supervisor	-	1
(ii) Rescuers	-	7 (3 up stairs and 4 on ground)

(c) **Equipment-It consists of:**

(i) Chute
(ii) Metallic Ring
(iii) Main Rope
(iv) Landing Cushion and window cushion
(v) Sheer Leg
(vi) Pickets to tighten

(d) **Procedure**

(i) **Preparation of the Sheer**

(aa) **Preparation of the Sheer**-If a sheer is used, it is lashed and fixed inside the building in a little tilted position towards the window. The lashing of the sheer should be at a level slightly above the window sill.

(ab) **Fixing a Cushion on window sill**-A cushion made of either foam or cotton measuring about 100 cms x 900 cms x 20 cms (in case of foam 30 cms) is fixed on the window sill, the inner end being secured to the legs of the sheer by ropes.

(ac) **Fixing of the chute ring to the legs of the Sheer**-The ring is then tied to the legs of the sheer conveniently at a slightly upper level than the window sill.

(ad) **Placing of a Stool for Landing inside the Chute** -An object of sufficient height is placed in front of the sheer for easy entrance to the chute.

(ae) **Lowering the Chute**-The chute is then gradually lowered by two men.

(af**) Pitching the Chute**-The ground men take the lowered end of the chute and stretch it as much as possible. They then fox two strong holdfasts on two sides at a distance of about 1.50 M from the centre and tie the ends of the four ropes taut to the holdfasts. The top of the holdfast's pickets should be cushioned.

(ag) **Placing a Cushion at the Lower end of the Chute**-A cushion made of cotton or foam measuring about 2 M x 2 M x 30 cms (60 cms in case of foam) is placed at the end of the chute taking half of it inside towards the wall.

(ah) **Pitching with Bracket-Clamp at the top for Clamp Chute**-The readymade bracket (walled from outer three sides up to a height of 2 M with iron bars and oil filter cloth) is placed on the window sill keeping its ring side external and the chute is lowered through the ring. The chute ring sits over the bracket ring. The lower end of the chute is not fixed to any holdfast but is held by men. The speed of coming down can be controlled easily by the man holding the chute. Other things are same as in sheer chute.

(ai) **Method of Evacuation**-No sharp or pointed or metal things on the person of the people slipping through the chute shall be allowed. They are to be searched before they are allowed to enter the chute. The people will slip through the chute in supine position. The hands are to be kept on the front part of the body in such a way not to allow the elbows to touch the chute sides. The heels should be up as not to abrade the chute cloth. It is better if the evacuees have full sleeve shirts and socks on. If necessary, an evacuee can control his speed by holding the main line above him.

(aj) **Position of Rescuers on Ground (for a Chute tied to holdfast)**-Two firemen/rescuers will stand at two sides on the cushion facing inwards for receiving the evacuees and helping them in getting up. Two men will hold the main rope taut. They can control the speed by slackening the rope if necessary.

(ak) **For a Chute with Bracket-Clamp at the upper end**-Two men hold the main rope and two men hold the corner ropes on the ground. The evacuees come down just as if lowered and they walk out ON THEIR OWN. For every evacuee the chute is to be slackened when he approaches the end and again thereafter held taut for the next evacuee. The speed is less and the evacuation time is more. In case of a sheer chute all through the evacuee comes inclined, while in case of the bracket clamp chute the evacuee first drops vertically and then comes inclined.

(e) **Application**

(i) Slanting chute can be used for a maximum height of 33 to 40 meters.
(ii) There is limited control on speed of descent and the casualty travels through the chute in lying position.
(iii) Its use is restricted to buildings not on fire.

18. **Vertical Chutes**

(a) **Constructions**-The chute body is made into spiral form with the main belt as the core one end of the chute main body is narrowed by securing firmly on to the main belt. The major parts of the chute are shown in figure below. The upper cloth is made of either polyester or any power cloth with high melting point. The majority of the chutes in use all over the world are fire resistant with self-extinguishing ability and hence are required to be used away from the direct flame. The chute can be designed for any length even up to 100 meters or more without compromising its strength. It weighs approximately 2 kgs per meter and all metallic part and components for fixing the chute either to the windows or doors are designed to withstand a total weight of approximately 1000 kgs.

(b) **Manpower**- The chute can be operated by a single person which includes installation and escape. In most of the high-rise buildings this equipment can be fitted as a permanent fixture.

(c) **Equipment**- The complete equipment consists of the following parts:

(i) Metallic frame for fixing the chute to a window door, roof or any other opening.

(ii) Outer body.

(iii) Inner body spiral in shape.

(iv) Main belt.

(v) Cabinet to store chute.

(d) **Rescue Procedure**-The following procedure may be used for using the equipment:

(i) Remove the chute from the cabinet.
(ii) Install the chute with the help of metallic frame to a window or door or any other opening.
(iii) Lower the chute.
(iv) Set up the entrance frame.
(v) Enter the chute with feet first.
(vi) Bend the knees as far as possible and descent with hop first.
(vii) Land on ground feet first.
(viii) Open exit and step out

NOTE-If a casualty happens to be trapped in a different floor, he should open the opening of chute at appropriate height and enter

(e) **Application**- The chute can be made use of under following circumstances:

(i) During high rise building fires but the chute should be hung away from direct flame to prevent fire shock and burn injuries to the escapee.

(ii) When the building is partially engulfed by fire and has a open flank.

(iii) Under circumstances where fireman have been partially successful in putting off the fire in a portion of the building.

(iv) Evacuation of marooned people during floods from roof tops.

(v) During earthquakes when the exit of high-rise building is blocked by debris.

RESCUE BY LIFE SAVING NETS

19. (a) **General**-

The first life-saving nets were hand-held blankets; later an inter-woven rope net was developed. What was ultimately required was a device small enough to fold into the compartment of a rescue apparatus, yet large enough to efficiently and dependably save lives. The circular life-saving net is a very useful device. The pioneer rope net was adequate coping with the requirements made on it during the early part of the century. Today's taller buildings require more dependable apparatus. The modern net consists of a fabric bottom supported within a 9½ foot (2.85 meter) diameter steel frame by 32 dual shock absorbers that distribute the initial force of the impact. The nets are available in half and quarter fold models for ease of storage: when in quarters the net's dimensions are approximately 7 feet (2 meters) by 2 ½ feet (0.75 meter): foot (0.3 meter). The shock absorbers reduce the impact normally absorbed by the personnel spaced around the net and make it possible for fewer members to handle it under safer conditions. Table below shows the kinetic energies of a falling body at different heights

Kinetic Energy Chart for a Falling 160-Pound Body

Hight of fall Feet	Length of time Second	Velocity at end of fall Feet per Second	Miles per hour	Force of impact pounds
10	0.80	23.60	17.45	1.638
20	1.10	35.20	24.00	3.097
30	1.40	44.80	30.55	5.017
40	1.60	51.20	34.91	6.553
50	1.78	56.96	38.84	8.410
60	1.95	62.40	42.55	9.732
70	2.10	67.20	45.82	11.287
80	2.25	72.00	49.09	12.960
90	2.38	76.14	51.91	14.477
100	2.50	80.00	54.55	16.000

(b) **Method of Netting**-Not more than 14 members or fewer than 10 should try to use the net Personnel should be placed evenly around the net with hands on every other grip; the net should he raised to neck level. Palms are spread and elbows are extended forward and slightly outward from the body. This allows the arms to move with the impact of the jumper permits the elbows to clear the crew's chests; thus injury from an elbow being forced into the body is averted. Net holders stand with their left feet forward and knees slightly bent for a resilient stance. Knees must never be locked. It is important not to span the hinged joints and rescuers should not purposely allow the net to give when the jumper lands. They should look up immediately upon assuming position. The officer should immediately start talking to the jumper, calmly reassuring the person and taking all steps necessary to prevent a premature jump. The officer will personally direct the final positioning by grasping the frame of the net with one hand, palm down, and issuing the necessary order with a gentle shove The person jumping should leap with arms outward and high overhead. The legs and feet should be kept together with legs extended forward and feet held as high as possible. It is best to land in the centre of the net on the buttocks or small of the back It is important to avoid a fees-first impact Rescue personnel on the side of the net away from the building must watch the jumper and be prepared to take vigorous and positive moves with the net in order to catch the person. Personnel on the inside with their backs to the building, must watch the outside members and follow through immediately with appropriate action. If a jumper should drop directly down her face of the building, the net must be forced against the wall and raised slightly higher at this point to assist in taking the impact. Serious injury to those members between the net and the wall may result if they do not take one of several courses afforded to them. The most desirable one, then if possible, is to drop out of position and remain clear of the net, the wall, and other members. Other alternatives are to drop to the ground beneath the net and attempt to keep the body clear of the centre point of impact or drop to the ground outside of the net and parallel to the wall. Members must be alert to the possibility that jumpers may strike overhead wires or other obstructions and thus change their course of fall. In the event that a number of victims attempt to jump, those caught should be quickly and gently rolled from the net on the side away from the building. The net should be relocated immediately in anticipation of another jumper. At the scene of an emergency, rescuers must never expose the net in the open position except when anticipating a jumper. If the net is loosely held or laid on the ground in an open position, a jumper may believe the net is ready and jump.

RESCUE WITH AIR CUSHIONS

20. **General-**

A jumping cushion is an improvement on jumping nets in the sense these cushions, the free fall which is not possible in a net. The cushion comes in the following types:

(a) Self inflating cushion.
(b) Foot pump operated cushion.
(c) Air blower cushion.

21. **Procedure**

The cushion having been inflated to capacity is held by the rescuers in position and the trapped person is given a signal to jump in the centre of the cushion which has an area of about 40 x 30.

22. **Storage**

The cushion requires to be stored in ideal conditions and with proper care and maintenance failing which the rubber will develop cracks and air will start leaking Sharp instruments, edges, rough surfaces should be avoided. Emergency repair kit should be kept handy and fresh chalk power is to be used while storing.

RESCUE BY HYDRAULIC PLATFORMS

23. **General**

Traditional rescue work has been depending upon ladders and ropes which is authorised to the rescue parties. However, in certain situations wherein quick rescue work has to be done at different levels of a high rise building, we can depend upon the hydraulic platforms held by the local services.

24. **Equipment**

The equipment consists of the following major parts: -

(a) Prime mover of appropriate tonnage
(b) Turn table ladder fixed in sections.
(c) Booms for elevation
(d) Platform (for rescue work).

25. This type of equipment is operated either mechanically or hydraulically. Further details can be had from the manual.

26. This requires stable and firm ground for the vehicle to stand and can be used to rescue about
6 to 8 persons at a time from roof top/various floors.

RESCUE BY HELICOPTER

27. Helicopters can offer invaluable help to the emergency services during rescue operations evacuate stranded persons/trapped persons from roof tops. Helicopter rescue can be conducted by actually landing on the roof top or by hovering and lowering a rope by which or by throwing a lie to the stranded person. However, aspects like strength of the roof top to withstand the weight of the helicopter, visibility condition specially in case of fire emergency

and presence of electric/telephone wire must be kept in mind before undertaking this operation. Details of this kind of operation a mentioned in Chapter 21.

RESCUE BY IMPROVISED GEARS

28. **Rescue Rack**

While carrying out the work of rescue at times a rescuer is required to go down to a lower floor to collect certain items or work freely at a given height. In order to facilitate this kind of work a rescue rack comes in very handy. The equipment consists of a main rope which is passed through grooved aluminium blocks (about four in number) and at the end of the block there is an arrangement to lock up the rope at any given height with the help of this rescue rack and a single rescuer can now work freely at any given height or come down to any floor freely.

29. **Rope Cage**

While carrying out rescue work by Flying Fox method or Jib Method a rescuer may face a situation wherein number of small children and women have to be rescued especially in large number. In such situations a rope cage comes in very handy. The cage consists of two iron rings to which a rope cage is woven and a eye sling made at the top to hook it to a pulley block. The cage has a rope door which can be closed once the people are seated inside

30. **Carabineer**

A carabineer is a versatile equipment which is being used very extensively by mountaineers. This equipment can be effectively used in C D rescue operations. This is made of aluminium alloy and oval in shape. It has an inverse opening lock through which the rope can be passed. This comes in various sizes and it can replace a snatch block which is at present in use by rescue parties. Some of the uses of a carabineer during rescue work are:-

(a) Raplling.

(b) Shifting from floor to floor by the rescuer.

(e) Inter building movements.

(d) Passing of tools/equipment/valuables by captive ferry method.

31. **Conclusion**

Rescue from heights is one of the most difficult jobs that a rescuer c undertakes, but his job can be made easy by use of different types of improvised gest explained.

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CHAPTER 16

DISPOSAL OF DEAD

1. **General**

In cases of disasters such as the floods, fires, earthquakes, railway accidents and the air raids the disposal of the dead bodies becomes a great problem due to various reasons. The dead bodies have to be disposed of quickly before they start decomposing Late disposal of dead bodies not only endangers the public health of the community but also affects the morale of the people. It therefore becomes essential for the Emergency Relief Organisation to handle this problem in a methodical and organised manner.

2. The recovery of bodies from demolished buildings is one of the duties of a rescue party Unless casualties (e.g., by of mutilation) are obviously dead, they should be treated by rese parties as alive until death is confirmed by a doctor. If there is no doctor available, a rescue party leader should take the responsibility of confirming death in clear cases, but, wherever there is doubt, the casualty-to avoid delay-should be handed over to the Ambulance Services Personnel.

PROBLEMS OF DISPOSAL

3. In normal times the disposal of the dead due to accident or otherwise is done after the necessary legal formalities are over by the relatives of the deceased or if unclaimed by some religious body or by the municipality. However, conditions are very much different in case of a disaster. Some of the reasons that make disposal of dead bodies a problem during an emergency are given below:

(a) The relatives who would normally carry out the disposal of the dead may have left the place in a hurry to save their lives.

(b) The relatives may be present but are unable to carry out the task of disposal e.g., in cases when the only survivor out of a family, is a child.

(c) The number of dead may be so large that the organisations such as Municipal/Religious Bodies that would normally dispose of unclaimed bodies are unable to cope with the situation.

(d) There occurs some delay and difficulty in the identification of the dead bodies due to various reasons, such as:

(i) **Mutilation of the body**-This may occur in case of fire, railway disaster etc.

(ii) **Decomposition of the body**-A decomposed body changes its colours and contours in such a way that even the near relatives are unable to recognise the body.

(iii) **Absence of relatives nearby**-This would happen in case of a train disaster, or in cases where the bodies are washed away due to floods.

FUNCTIONS OF CORPSE DISPOSAL SQUADS

4. Some of the functions of Corpse Disposal Squads are:-

(a) **Assisting in tasks normally carried by the police**-These are the holding of summary enquiries (inquests, panchanamas) which include identification of the dead, taking custody of valuables and personal effects and completing the records needed.

(b) **Tasks normally carried out by the relatives or in their absence, by the municipal or religious bodies-**These include removal of dead bodies to burial ground or the burning ghats and arranging for final disposal at these places according to denomination of the dead.

ORGANISATION FOR DISPOSAL

5. The disposal of large number of dead bodies should only be done through an organisation called Corpse Disposal Organisation which should be on the following lines:

(a) **Corpse Disposal Squads**-The organisation will consist of many small units called Corpse Disposal Squads. Each squad will consist of one leader and four members. The main responsibility for the disposal of the dead will be that of the person in charge of the Medical and Public Health in the action committee. He may, for the sake of convenience and efficient functioning, appoint a sub-committee consisting of representatives of the local municipal bodies, the police authorities and any local religious bodies, with himself as the Chairman.

(b) **Number of Units and location**-The number of squads per town/tahsil would decide after considering the vulnerability of the area to disaster and the population of the have to be place. These should be located at a convenient place le near the municipal office where death pass is issued and should have a telephone nearby if possible.

EQUIPMENT

6. The following equipment should be made available to the disposal squads

(a) **Transport**-This is the most important requirement of the corpse disposal squads, as in an emergency, physical carrying of dead bodies is neither feasible nor desirable The dead bodies are to be carried in such a manner that the public does not see them while being transported. Further, the disposal has to be quick enough to prevent bodies getting decomposed. For these reasons, load carrying vehicles with tarpaulin covers are desirable. In the absence of these or to supplement these, bullock carts and other means of conveyance can also be used provided proper covers are made available.

(b) **Equipment for loading of dead bodies**-Ropes, stretchers or substitutes, sheets or cloth to cover the bodies will have to be supplied.

(c) **Personal protection equipment**-Certain items such as hand gloves, towels, disinfecting fluids nose-pads will be required to be issued to the volunteers to keep themselves free from possible infection.

(d) **Burial/burning ghat necessities**-These may have to be arranged. Thus spades, picks, baskets are required at the burial ground. Also, cloth, fire wood, ghee etc. for disposal of bodies according to religious rites.

(e) **Identification duty equipment**- Equipment needed to take finger prints and photographs of the unidentified dead may have to be issued.

(f) Standard tie-on casualty label for NBC casualties.

(g) Gloves to handle decomposed bodies.

(h) Breathing apparatus for functioning under NBC and area with foul smell.

FUNCTIONING

7. Members of the C. D. Squads in each town will be required to collect the dead bodies or their remains lying superficially at the scene of disaster. They will also take over the bodies extricated by the members of Rescue Parties who would furnish necessary information to C. D. Squads regarding name, place, time, valuables etc. found on the person of the dead body. All these bodies will be carried to a well-covered protected place where they will be kept pending identification. However, the above work by C. D. Squads will be started only after a Police Official/Magistrate has arrived on the spot and has ordered collection of dead bodies, as in all cases of unnatural death they have to hold a summary enquiry and prepare necessary records. Since the number of police available for doing these duties will not be enough the members of CD. Squad will have to assist them in preparation of records and listing the valuables found on the dead body.

TRAINING

8. The volunteers would require training in doing their jobs properly. They will have to be told about the law of the land regarding inquest or panchnama to be held. They must know how to recognise signs of death, what to do with the valuables of the deceased, how to initiate records for identification, the working of the organisation, the disposal of bodies and disinfection of mortuaries and vehicles and personal hygiene. The training should be arran by a sub-committee consisting of representative of Police, a medical practitioner, Head of Corpse Organisation and C.D. Training officer.

LABELLING SYSTEM

9. Bodies must be labelled as soon as they are recovered. Standard tie-on casualty label are issued to Rescue Parties and are to be used on all occasions. In the event of the supply running out, the information required can be written on a piece of paper and attached to a button or pinned on the clothing. The information to be supplied by members of the Rescue Section deals with:-

(a) The address of the premises where the body was recovered.

(b) The position in the building (if this can be defined).

(c) The time and date, when recovered.

(d) Apparent cause of death (e.g., bomb splinters, falling masonry, fire etc.) as certified wherever possible by a doctor.

(e) Any other special information which might assist in identifying the body (e.g., name of casualty if known)

(f) The signature of the Rescue Party Leader or his Deputy.

10. Forehead of casualty should be marked with the appropriate symbol using indelible pencil. The following symbols must be entered on reverse side of label:

(a) If body is contaminated or suspected of having been contaminated by persistent gas, label should be clearly marked with a "C".

(b) For those suspected to have died from effects of poisoning by nerve gas or non-persistent gases, label should be clearly marked "XX".

(c) For those suspected to have died from radioactive effects label should he clearly marked "R".

DISPOSAL

11. **Collection of Bodies**

When bodies are recovered, they should be deposited in the nearest convenient building and some suitable covering placed over them pending removal: they should not be left on the highway or in open space. The public and all persons not directly concerned should be kept away whilst bodies are being recovered. The dead should be treated with due respect, but priority must always be given to the living. Parts of bodies should be placed in metal bins, labelled in the manner already stated, to await removal.

12**. during Collection**

Whenever possible, rescue workers who have to handle human remains should use the rubber gloves issued for the purpose. Where necessary, they should tie a pad or handkerchief, dipped in some deodorising fluid, over nose and mouth. Where such fluid is not available, wearing the respirator will help to overcome any nausea caused by foul smells.

13. **Temporary Mortuary**

The bodies are brought to the temporary mortuary which may be located at some shed, godown or vacant building. It should be a place well protected from public view as the sight of large number of bodies have a very demoralising effect on the on-lookers. After the necessary records have been completed at the mortuary and the medical officer (or a trained volunteer) has certified death and police satisfied that the death has not occurred due to any foul play, the bodies which are identified will be handed over to the relatives or friends who claim them, after obtaining their signatures. The valuables and other personal property will be handed over to the nearest relative on orders from the police who are the custodian for the same.

14. **Identification of the Body**

If the dead body is disposed off without its identification being established, it may give rise to some problems of inheritance besides hurting the feelings of relatives and friends as and when they come to know about it. Every effort should, therefore, be made to establish the identity of a dead body before disposal. With a view to facilitate identification it would be necessary to take the following steps right from the beginning the body is recovered.

(a) Note the place, time and situation under which the body was found. If the body was handed over by Rescue Party they should furnish the above information on a card and sign the same.

(b) Description of clothes worn, contents of pockets, letter etc.

(c) List of valuables such as rings, wrist watch, bangles, ear-rings etc. found on the body.

(d) General description of the body such as age, sex, identification marks, colour of hair and eyes, complexion, height deformities, vaccination marks, dentures occupational marks etc.

(e) Finger prints may perhaps help in certain cases and may be taken after death.

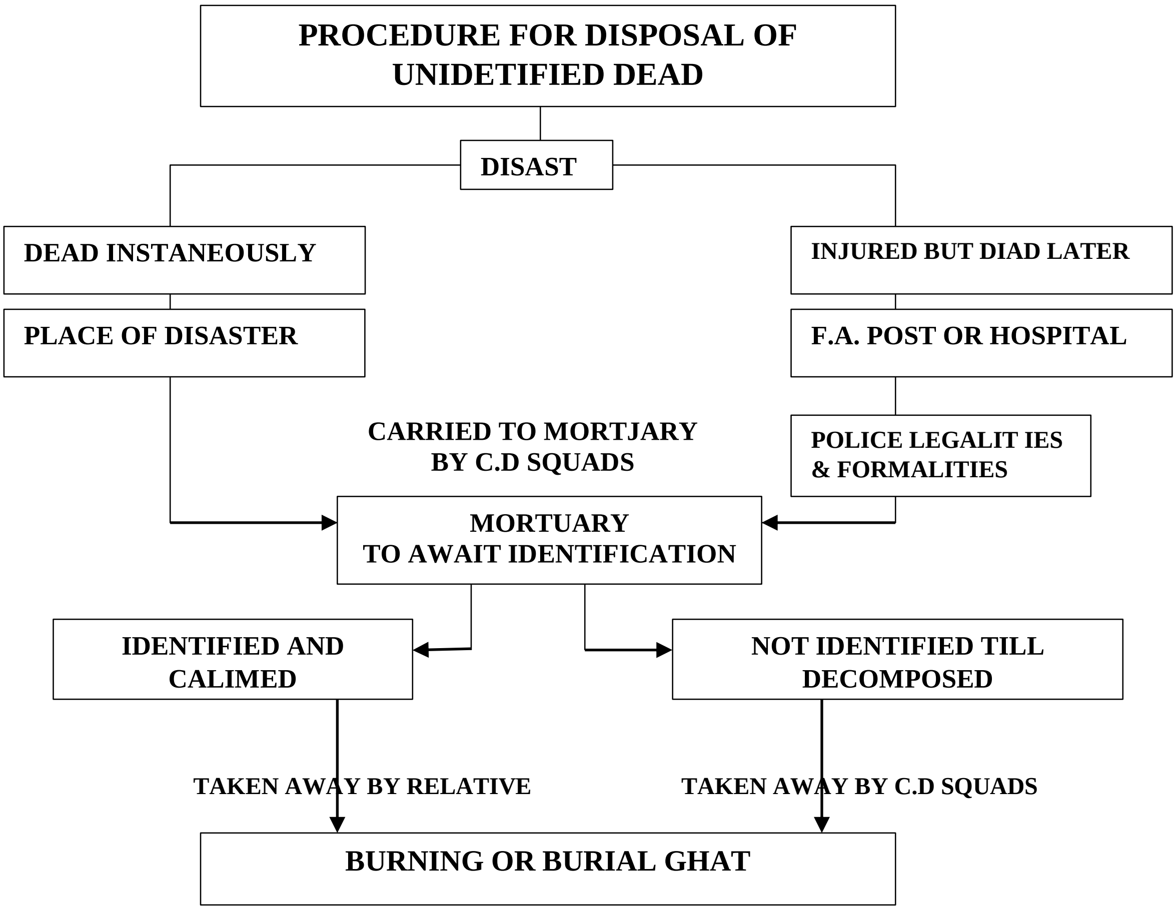
(f) Whenever photograph is taken it should be done before decomposition sets in.

UNCLAIMED BODIES

15. Those bodies which are not claimed by any one or where relatives are not in a position to receive them as it may happen in the case of a child who is the sole survivor, the C. D. Squads will have to arrange for their disposal. For this purpose, they will have to be provided with necessary facilities for transport of the dead to the cremation ghat or burial ground. At the cremation ghat/ burial places a religious person viz. a Priest or Granthi, Mulla etc. should be available to perform the last rites of the deceased. The necessary material for disposal of the body i.e., fire wood, ghee, cloth, digging implements along with the necessary labour etc. should be available, Indiscriminate disposal of the bodies may lead to demoralisation amongst the public and such a step would injure their feelings.

UNIDENTIFIED BODIES

16. Some of the bodies recovered and kept at mortuary may not be identified by anyone. The person in-charge of the mortuary will be faced with the difficulty of keeping such bodies for unlimited length of time which will be impracticable from health and sanitation point of view. Bodies may have to be kept pending arrival of the relatives who might have been informed. All such bodies may be properly arranged to minimise unnecessary viewing. They should be so kept that decomposition is minimum. A cool well-ventilated place, protected from direct sunshine considerably helps to slow down the process of decomposition. When bodies have to be kept longer under unfavourable conditions artificial means for preservation such as ice packs, chemical preservatives etc. may be used. In most cases however, it would be desirable to dispose of bodies as early as possible after the completion of necessary records as mentioned in the subsequent paragraphs.



Disposal of Unidentified Dead

17. **Determination of Religion**

(a) It may happen, in some cases of unidentified bodies that their religious denomination is not obvious. It should be the responsibility of the Officer-in-Charge Morgue to give orders in this respect after consideration of the circumstantial evidence in each case of doubt. He should make entry to this effect in the labels attached to dead body and thus indicate as to which place-Burial or Cremation Ground-the body should be carried.

(b) The In-charge of the burial or cremation ground should make entries in his register from the labels attached to each corpse. Disposal of bodies without these labels should not be permitted. The labels attached to dead bodies will be removed and returned to proper authorities duly completed by the In-charge of burial or cremation grounds.

18. **Conclusion**

It would thus be realized that disposal of dead bodies produces many problems and the suggested procedure will obviate all unnecessary delay in the disposal. All the same in view of the legal, religious and moral aspect of the problem the task should be undertaken with all possible care and seriousness.

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CHAPTER 17

REPAIRS, DEMOLITIONS AND SALVAGE

REPAIRS

1. **General**

It is necessary to make prior arrangements for the quick repair of large-scale damage that may result from an air attack. The object is to restore normal life as quickly as possible and ensure maintenance of public morale thereby. Generally, it will be the responsibility of the appropriate authorities to undertake repairs for which they are normally responsible in peace time They should augment and equip their Repair personnel to deal with added risks of war. Rescue service may assist if not required for their primary work of rescuing lives or recovering the dead from damaged buildings

2 **Repairs to Property**

After an air raid a large number of buildings may become damaged, rendering residents of those buildings homeless. While these people will find temporary shelter in Rest Centres, the solution lies in rebuilding and repairing the houses that are damaged or destroyed. Whilst it is not possible during the war conditions to undertake the reconstruction of buildings which has been destroyed or undertake extensive repairs to buildings which had been badly damaged, there would be a large number of buildings the whole or parts of which could be made habitable after minor repairs. These buildings, after they are restored to habitable condition, would provide permanent accommodation for a number of homeless families. It is, therefore, desirable that :-

(a) Privately owned premises which have been slightly damaged by air attack should be rendered habitable as soon as possible after the damage has occurred. Urgent repairs would also required for shops dealing in essential commodities, emergency catering establishments, Rest Centres, hospitals etc. In many cases public will be willing to undertake their own minor repairs. In that case some arrangement will be necessary for providing and distributing building material on the spot for small repairs. State Governments should undertake repairs only when the premises are required to house the homeless and the owner himself is unable to effect the repairs.

(b) Such repairs should not extend beyond that which is necessary to render the buildings fit for habitation. This would not include interior decoration and replacement of fittings etc.

(c) Arrangements should be made for the early inspection of slightly damaged premises by a person authorised to decide on the extent of the repairs necessary and a record should be kept of approved cost.

(d) Repairs would only be undertaken by the State Government if:

(i) There is a real need for the building to be made habitable"

(i) That it will in fact be inhabited as soon as the repairs are done.

(ii) That the expenditure is restricted to the minimum necessary for making the building habitable, and

(iv) That relief is afforded only to those who are unable to carry out the repairs without it.

(e) Repairs to property of industrial and commercial undertakings, business premises, premises of public utility undertakings, transport services and government buildings, should be carried out by the authority responsible in peace time for such repairs.

3. Arrangements must be made with local PWD authorities, who should set up Repair and Demolition Squad for this purpose under their control, to ensure that necessary stock of material and implements are available for repairs. These squads will also undertake demolition work described in para 5 below. Special arrangements must he made for public utilities viz, electricity, gas, water etc 10 restore the essential services in the damaged buildings are quickly as possible. The problem of labour must be kept in view. The labour becomes scare in target areas. Labour skilled or unskilled will be required on large scale. Adequate transport will be required for moving labour, debris and material

4. **Repairs to Roads and Clearance of Debris**

Roads culverts bridges are likely to be damaged by high explosive bombs during air raids and if they are not quickly repaired, they would badly affect communications between several parts of a town resulting in lowering the morale of people and will be a severe handicap to CD Services. The roads may also be blocked by debris or falling masonry from the damaged building as well as due to craters caused by the impact of H E bombs. It is desirable that the work for the clearance of debris from the roads etc as well as repairs to roads should be undertaken by the Municipal authorities/PWD/Corporations concerned so that the roads are put into commission as soon as possible.

5 **Repairs to Essential Services**

The services like water supply, sewerage, electricity, telephones, telegraphs and gas works usually maintain their own repair gangs, which should be suitably expanded to meet the exigencies of air raids. Repairs to Ferris, Docks, Harbours, Canals, Railways etc will also be carried out by the concerned authorities themselves.

DEMOLITIONS

6. Some buildings damaged during air raids might be standing in dangerous condition and might constitute potential sources of danger to the public. Their presence near road side might endanger lives and traffic on the roads. Hence it will be necessary to get these buildings dismantled as quickly as possible to remove the source of danger and also to restore traffic along the roads. Demolition of some buildings may necessitate the use of explosives. This work should, therefore, be undertaken by Repair and Demolition Squads referred to above, except that the demolitions involving use of explosives may be undertaken with the help of the military authorities where possible.

7. Details of various techniques of controlled demolition has been discussed in detail in Chapter 14.

SALVAGE

8. **General**

During air raids many houses might be destroyed or damaged simultaneously burying large quantities of valuable property under the debris and the owners may become casualties or may run away out of fear. If these properties were left uncared for, they would be either stolen or destroyed by exposure. It would be impossible for the Police to take charge of these properties, remove them to a safe place and keep them in custody until the appearance of the rightful owner. Nor could this work be entrusted to the Police as Civil Defence measure as the Police will have many other duties to perform. Hence it will be necessary to have a separate post-raid organisation which may be called the salvage Organisation and which would be responsible for salvaging properties from houses destroyed or damaged by air raids and for taking care of such properties and their eventual disposal or return to the owners.

9. **Organisation**

It will, thus, be necessary to set up a suitable organisation in every town under the responsible Officer. He should organise salvage operation through the local PWD or utilize Rescue Parties during non-alert period if it does not interfere with their normal duties. The arrangements for salvaged property should include:

(a) Arrangements for its custody by an appropriate officer who may be called a Custodian.

(b) Provision of suitable places to serve as godowns for storing and guarding the salvaged property till the owners can be traced.

(c) Maintenance of proper accounts.

10**. Manpower and Equipment**

To enable the Custodians to discharge their duties efficiently they should be provided with necessary staff and equipment e.g. a watchman an accountant and a vehicle. Necessary labour could be engaged on daily wages required. The parties so organised will be known as Salvage Parties. Salvage party with Police accompanied by a Magistrate should reach the spot and after putting a cordon, a further action should be taken in the presence of the Magistrate. Details of personnel and equipment are as under :-

(a) **Scale of Personnel**

(i) Custodian or/and Assistant Custodian.	1 upto 3 lakhs population and one extra for every additional 3 lakhs pops
(ii) Salvage team consisting of 1-Supervisor 1-Driver 4-Labourers (to be employed on daily wages).	1 per one lakh population.
(iii) Accountant (Godown i/c)	1 per godown
(iv) Clerk	1 per godown
(v) Attendant	1 per godown
(vi) Watchman	1 per godown
(vii) Godown	1 Godown upto 3 lakhs population and one extra for every additional 3 lakhs population

(b) **Scale of Equipment**:

(i) **For Salvage Team**

(aa) Vehicle	1
(ab) Baskets	8
(ac) Spades with handle	4
(ad) Ladder (bamboo)	1 (about 10-12 ft. long)
(ae) Rope lengths ½" & ¾ " about 50 ft long	4pcs
(af) Jute string (sutli)	5 seers
(ag) Gunny bags	2 doz.
(ah) Torch (two cells)	1
(ai) Crowbar chisel 66" long	1
(aj) Pickaxe, chisel and point, with handle.	1
(ak) Axe 4 lb with handle	1
(al) Handsaw 26" cutting edge with handle	1
(am) Sledge Hammer 8 lbs with - 1 handle.	1
(an) Tarpaulin 18' x 18'	1
(ao) Standard ceiling hook	1
(ap) Saw Dust (for putting bunds and canalising water)	1 bag
(eq) Crude oil (for coating machinery to prevent it from rusting.	2 gallons.

(ii) **For Personnel**-1 Helmet per member including driver.

TYPES OF SALVAGED PROPERTY

11. The salvaged property will generally fall under two broad categories i.e., perishable and non-perishable.

(a) **Perishable**-Perishables may be disposed of and the amount realized be held by the Custodian on the owners' account. If there are any useful perishables such as food grains they may be handed over to the Rationing Authorities, if any, suitable compensation paid to the owners.

(b) **Non-Perishable**-As regards non-perishable, custody of the building material may be entrusted to PWD authorities, and other property may remain with the Custodian as above unless the owners are present and offer to take the property away.

(c) **Valuables**

(i) **General Provisions-**If any valuables like ornaments, gold, silver, bank notes or other documents of value are found arrangements must be made so that they are sent by the Custodian to Government Treasuries or banks for safe custody. It is suggested that while salvage operations are proceeding, an inventory of salvaged property should be prepared on the spot by the Salvage Officer in accordance with the procedure laid down by law, and copy furnished to the Civil Defence Controller immediately. Valuables should be listed in the presence of a Magistrate. Care must be taken to guard against any mishandling of or lost to salvaged property.

(ii) Finding-It frequently falls to the lot of rescue personnel and others assisting them to find money and valuables. As a person who improperly retains any such property removed from bombed premises is liable to very severe punishment, it is most important that members of the Armed Forces, the Civil Defence Corps and the general public should clearly understand their responsibilities and liabilities in this matter.

(iii) **Disposal**-Any article of value, however small, found on bombed premises, must be handed over immediately to the party leader or section commander who will arrange for it to be given to the Senior Warden, Post Warden or to the senior police officer on duty. The greatest possible care must be exercised in this direction. The only safe course is for the finder immediately to declare his find to his colleagues, and as soon as possible to hand the articles to a responsible officer, as in the preceding paragraphs, and obtain a receipt for them.

12 **Legal Provisions**

State Governments may appoint Officers entrusted with the task of salvage and custody of salvaged goods. The Central or State Government may be general or special order provide:

(a) for the clearing of any premises which, in consequence of enemy action, accident or otherwise, are substantially damaged;

(b) for the protection of articles or things left upon such premises as aforesaid;

(c) for the removal, custody, disposal or restoration to owners of any such articles or things as aforesaid, including the disinfection or destruction of articles or things which may be a source of danger to public health or safety.

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CHAPTER 18

RESCUE OPERATIONS UNDER NON-CONVENTIONAL STRIKE ENVIRONMENT

1. **Introduction**

The first acquaintance of the public with nuclear energy was as the l of weapon usage at Hiroshima and Nagasaki in 1945. The bomb dropped no Hiroshima had a destructive power of 20 KT TNI and instantly destroyed an area of 5 square miles around the Ground Zero, killed 7800 and injured 2.73.000 people. Ever since then more and more effective and efficient ways of harnessing the energy of the atom have been discovered both in destructive and so destructive modes. Hydrogen bomb, Thermo Nuclear bomb and Neutron bombs are some of them.

2. Considering the devastation that resulted in Japan, the C D organisation considered adequate for conventional attacks would be grossly inadequate to cope with the enhanced problems under nuclear strike.

3. Perhaps adhoc organisations and arrangements would have to give way to more permanent measures of any reasonable degree if survival is in be achieved.

EFFECTS OF NON-CONVENTIONAL STRIKE

4. The most destructive constituents of the nuclear explosion are:

(a) **Flash Effects**

(i) **Dazzle Effects**-Also known as Flash blindness. It is temporary loss of vision resulting from the brightness of the burst. During day light individuals facing the dazzle will be blind for 2 minutes and at night for 10 minutes. Those facing away from the burst are likely to be dazzled for 3 minutes in the night.

(ii) **Eye Damage**-Retina burns occur when the eye lens focuses the fire ball image on the retina. This causes shallow burns which lead to permanent blind spots. However, there is no permanent loss of eye sight.

(b) **Thermal Radiation**

(i) **Burns**-Due to the heat. flash skin burns of various degrees of severity will be caused at various distances. There may be more (first degree) or a more painful blistering (second degree). The burns will depend upon the total amount of heat, area on which it falls and the duration of application of this quantity of heat to the surface. The range of heat effects on people exposed in the open for 20 KT and 10 MT bombs air and ground burst are given in the Table below:

Type of burn	20 KT		10 MT	
	Air Burst	**Ground Burst**	**Air Burst**	**Ground Burst**
aa) 3rd degree	1 ½	$^{7}/_{8}$	22	13
ab) 2nd degree	1 ¾	1	25	15
ac) 1st degree	2 ½	1 ½	35	21

(ii) **Fires**-Armand the ground zero up to a certain distance everything is completely destroyed by fine, this is known as the main fire zone. Around this will be a zone in which all combustible material will catch fire and other non-combustible material is their contact will also catch fire Fires started like this will range from ½ to 5/8th of a mile. For a H-Bomb ground but this may extend from 3 ½ to 12 miles. Fires will also he caused due to collapse of buildings, on domestic fires, breaking of gas pipes and short circuiting of electric wiring These are known as secondary fires. Many isolated fires are caused due to the primary and secondary reasons. In case of a nominal bomb air-burst such isolated fire will be caused up to about 2 miles and for a H-Bomb ground burst up to about 17 miles. The table below gives the range of the main fire zones and the limit of isolated fires from air and ground burst of nominal and the 10 MT weapons. It will be noted that the air burst causes much greater damage than ground burst. The main fire zone is ring shaped, within this range many fires will be extinguished by the general destruction if the houses and buildings. The table below gives the ranges of fires:

Type of burn	20 KT		10 MT	
	Air Burst	**Ground Burst**	**Air Burst**	**Ground Burst**
aa) Main fire Zone	1 to 1 5/8	3/8 to 1	4 to 20	3 ½ to 12
ab) Limit of isolated fires.	2	1 ½	28	17

(c) **Blast Effect**

(i) **Structure**-When the nuclear bombs detonate 45 percent of the total energy appears in the form of blast and shock wave. The blast is of excessive over pressure of the order of thousands of atmospheres. With the air burst this is added up by the wave reflected from the ground. This appears in two phases, the pressure and the suction phase. Whereas in case of HE Bombs, the suction phase is responsible for the structural damage, the pressure phase itself which acts as a gigantic hammer on all the objects. The pressure phase in case of H E Bomb lasts for 0.005 seconds, in case of nominal bomb it is ten to fifteen times more i.e., about 0.7 to 1 second and for 10 MT bomb it lasts for about 5 seconds. The ability of a building to withstand the of the blast wave depends on the strength, shape and openings in the building. The openings serve to relieve the pressure on the outside walls. The structural damage can be divided into four zones Le. (aa) Complete destruction, (ab) Irreparable (ac) Moderate to severe damage and (ad) Light damage around the ground zero. In case of Hydrogen Bombs a ground or near ground burst is more likely since it creates additional fallout hazard without seriously affecting the blast and heat effects, which still cover greatly than most likely built-up targets. The Table below shows the (aa), (ab). (ac) and (ad) damage ranges for 20KT and 10 MT ground burst. Since the range of blast damage is much greater for an air burst than for ground burst, for practical purposes the ranges given in the table may be increased by 30 percent to get ranges for air burst at optimum height.

Damage Zones	20 MT	10 MT
(aa) Damage Zone-Houses totally destroyed, streets impassable	0-3/8	0- 3 ½
(ab) Damage Zone-Houses irreparably damaged, streets blacked until cleared by mechanical aid,	3/8 -5/8	3 ½ - 5
(ac) Damage Zone-Severe to moderate damage to house. Progress in streets made difficult by debris	5/8- 1 5/8	5-13
(d) Damage Zone-Houses lightly damaged, street open but some glass and tiles	1 5/8 -2 ½	13-20

(ii) **Human Body**-Since the human body can withstand pressures, better the structures, there will not be much injuries due to direct blast but many people will be injured due to indirect effects of blast such as collapse of building, falling debris. Flying glass and splinters. For a nominal bomb air burst these would occur up to 2 miles, At greater distance the casualties due to flying glass will be more.

(d) **Radiation Effects**

(i) **Human beings**-The damage caused by the nuclear radiation to human body is by killing the body cells. This depends upon the amount of radiation received (called dose) and the part of the body which receives it. The biological effects of radiation on whole body may become apparent in four successive phases.

(aa) **Radiation Sickness-**This is caused by the damage to gastro-intestinal tract. It may develop within a few hours to 24 hours depending upon the dose received. It may last for 2 to 3 days Usually radiation sickness occurs at doses of 150 R and above. The earlier symptoms are fatigue, nausea, indigestions, loss of appetite which may develop to vomiting, diarrhoea, may be with blood etc, with higher doses.

(ab) **Delayed Effects**-The delayed effects like loss of body hair with appearance of blood spots due to haemorrhages under the skin, occur after about four weeks or so, when the blood forming system is injured by radiation.

(ac) **Long-term Injuries**-These are anaemia blood cancer, bone or tissues cancer and tumours which usually develop many years after exposure. Premature ageing may occur. These dangers are not imminent below a dose of 100 R

(ad) **Genetic Damage**-When the reproductive organs and germ cells which transmit the heritable characteristic to future generations are affected, genetic damage is caused. The damage caused by radiation is directly proportional to total dose received by the population i.e., whether a few get high doses or a larger number get lesser doses.

(ii) **Radiation Hazards due to Atomic Bomb Explosion**

(aa) **Initial Radiation-**These travel outward from the centre of explosion. They consist mainly of Gamma rays, Gamma rays are penetrating and they will produce dosages in the case of a nominal air burst bomb as follows:-

Distance from GZ	Total Dose	Effect on Human Body
At ½ miles	5000 r	Certainly fatal.
¾ mile	500 r	50% lethal, Majority victims get sick Less than 1%, few get sick
1 mile	100 r	Less than 1%, few get sick.
1 ½ miles	5 r	Nil No sickness

(ab**) Residual Radiation**-In the case of nominal air-burst A-Bomb explosion the products of explosion are sucked up very high and dispersed in the atmosphere. By the time these come down to earth much time (years) is elapsed so that the radioactivity is reduced to below harmful level. Hence no immediate fallout problem arises. However, when a bomb is exploded near ground level radioactive particles contaminate larger and heavier particles of earth etc. and these are deposited quickly on ground. The deposited radioactive material in the fallout area creates radiation hazard. If it comes into contact with body or clothing acute skin Hurns which are difficult to heal may result. In case it enters body through inhalation, or ingestion it is one of the deadliest poisons and will cause acute radiation sickness, genetic troubles and death due to these radiations. The radioactive deposits might contaminate exposed food, water and crops and create serious problems of protection, control and decontamination. In the case of a nominal bomb ground burst, this may extend to a couple of miles downward. The table below gives the various doses of Gamma radiation received in a single exposure and the probable effects on human beings.

Probable Effects on People of a Single Exposure to Gamma Radiation

Single dose range in Roentgen(R)	Mortality at 24 hrs	Mortality of 6 weeks	No incapacitated within 24 hrs	Probable time of unfitness for any duties of those affected
0-25	0	0	Negligible	2-3 days
25-75	0	0	a few	2-3 days
75-100	0	Less than 0.1%	up to half	1-2 weeks
100-150	0	Less than 0.5%	At least half	about 3 weeks
150-200	0	up to 5 %	At least three fourths	Not less than
200-400	Unlikely to be any	about one third	Probably all	3 months
400-600	Perhaps a few	About half	Probably all	3 months
Over- 600	Likely to be some	almost half	Probably all	3 months

(iii) **Radiation Hazard from Hydrogen Bomb Explosion**

(aa) **Initial Radiation Hazard**-With the larger bombs the radio-activity also increases However, distance and shielding effect of intervening media do not allow the range of 50 percent lethal dose for a 10-megaton bomb to go beyond 2½ miles and beyond 4 miles from ground zero there is no significant risk Since these distances are within or near about the range of total destruction due to blast, the hazard from initial radiation could be ignored.

(ab) **Residual**-However, fallout from explosion of larger bombs can be very extensive and poses a serious threat to cities, villages, industries etc, which lie in the fallout area. The US Atomic Energy Commission in a report stated that the H-Bomb exploded at Bikini Island on

1st March. 1954 contaminated cigar-shaped area extending approximately 220 miles down wind and varying in width up to 40 miles.

RADIATION MONITORING

5. **General**

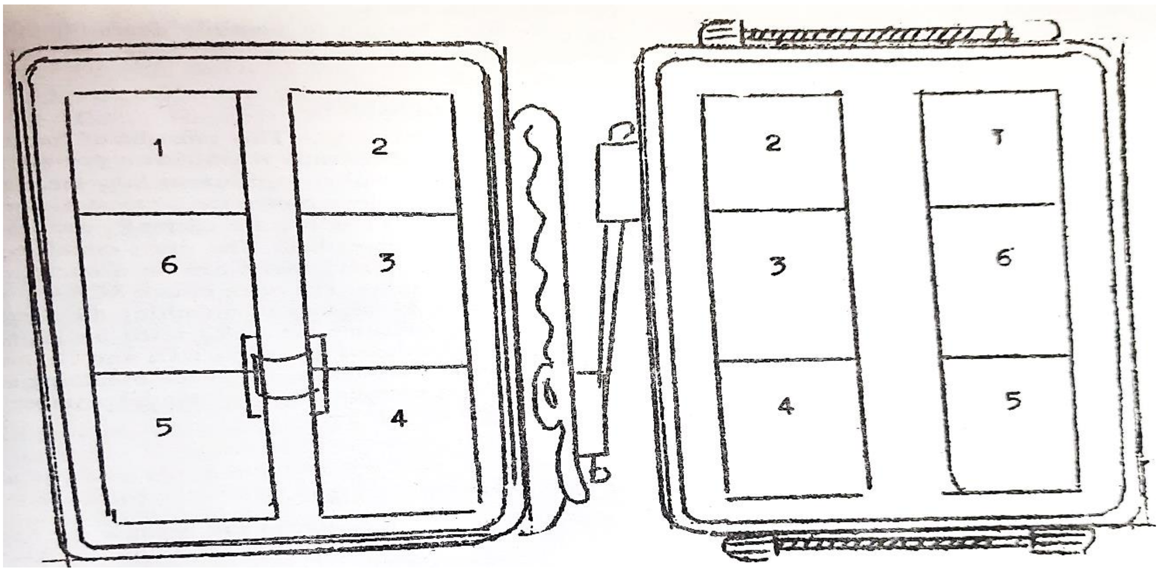
Instruments used in radiation protection serve a wide variety of purposes. There. for instance, instruments such as geiger counters that measure individual ionizing particles, film badges and pocket dosimeters that record accumulated doses and ionization chamber type instruments that measure dose-rates. In each of the above categories, there are instruments that are designed principally for measurement of a certain type of radiation such as lo-energy X-rays, gamma rays, fast neutrons etc. In spite of the wide diversity in these instruments, the operating principles under which they work are relatively few. The basic requirements of any radiation measuring instruments is that the detector part of the instrument interacts with the radiation in such a manner that the magnitude of the instrument's response is proportional to the radiation effect, of radiation property, under measurement. Figure below presents the physical and chemical radiation effects occurring in different types of instruments used in radiation protection,

6. **Personal Monitoring Instruments**

(a) **Pocket Dosimeters**-Pocket dosimeters offer a quick easy and fairly reliable means of measuring the day-to-day exposure of persons working with sources of radiation. Two types of dosimeters are in use, both operating on the principle of the 'air wall' ionization chamber and based on the operational definition of the roentgen. The first type is the condenser meter of the indirect reading type i.e., a charge-reader, otherwise known as a minometer. Commercially available condenser type pocket dosimeters measure integrated X or gamma ray exposure doses up to 200 or 500 mR with an accuracy of about 15% for photon energies between 0.05 to 220 MeV. For energies outside this range, suitable correction factors are used. The dosimeters also respond to beta rays of energies up to 1 MeV. By coating the inside of the chamber with boron, the dosimeter can be made to respond to thermal neutrons. The standard type of pocket dosimeter, however, is designed for X and gamma rays only and is calibrated with either CO^{60} or radium gamma rays. These dosimeters discharge rather slowly dosimeter that leaks more than 5% of the full-scale reading should not be used. Usually, two even when they are not in a radiation field mainly because of cosmic rays and leakage. dosimeters are worn at a time, with the lower of the two readings taken as more accurate. It is necessary to recharge the indirect reading pocket dosimeter after every reading. A separate charging unit should be used for this. The direct reading dosimeter operations on the principle of the gold leaf electroscope. A quartz fibre is displaced electrostatically by charging it to a potential of 200V. An image of the fibre is focussed on a scale and is viewed through a lens at one end of the instrument. Exposure of the dosimeter to radiation discharges the fibre, allowing it to return to the original position. The Amount discharged is proportional to the exposure: Ranges are 0-200 mR or 0-500 mR. For Civil Defence purposes dosimeter with range 0-5 r and 0-50 r are used. Readings are accurate to +15% for energies from 0-05 to 2 MeV. An auxiliary charger is used with the dosimeter. Pocket dosimeter are generally integrating type dosimeters. They are also suitable for area monitoring work in which case chambers of larger volumes are used. Such stray radiation chambers are more sensitive than the pocket dosimeters. These chambers are especially "useful in monitoring scattered radiation from medical and dental X-ray apparatus. A third type of ion chamber dosimeter may be mentioned briefly. This is known colloquially as a "pocket screamer" and is designed to give audible warning when a certain integrated dose has been received. The British version (AERE Type 149qA) is available with a number of present sensitivities- 0.1 r. 0.5 r. 1.0 and 50 r. There is also a German model which operates at 30 mr. A modification of the British dosimeter will include a meter which is visible to the wearer and will record 25 mr at full scale deflection.

(b) **Film Badge Dosimeters-**The degree of blackening produced on a photographic film by radiation, as measured by a 'densitometer can, if properly calibrated, be used to measure the radiation exposure. A photographic film badge ordinarily contains two films, one a high speed' film for low ranges and the other a 'slow' film for higher ranges. The film pack is normally covered with a variety of filters to (i) reduce the energy dependence of the film specially for low energy gamma and (ii) assess separately the dose contribution from different types of radiation. A great variety of film badges have been used in different installations. The film badge in use at BARC has to metallic frames hinged together, each frame having a set of filters (1 mm Cd. 1 mm Pb, 1 mm Cu, 0.15 mm Cu and 1 mm Perspex) The filters are so arranged on the two halves of the holder so that each is a mirror image of the other except for a small gap in the rear half. 'V' shaped groomers are out off the lead filter to facilitate detection of incidence of radiation and the manner in which the film was loaded while being exposed. In cases of X-rays in the diagnostic region, the difference in densities under the open window, 0.15 mm Cu and I mm Cu are employed to ascertain the radiation dose and subsequent dose evaluation from a calibration chart. For the exposures the densities under the open window and the 1 mm Pb filters facilitate assessment of the energy and the corresponding dose. For gamma doses, the density under Pb filter is used, Beta exposure is recognised by preferential darkening under the open window and the Perspex filter. The ratio of the densities under these two regions can be used to determine the beta energy. This is done with the help of a calibration chart. The 1 mm Cd provides a means of estimating the thermal neutron dose. Fast neutrons can be estimated by counting the density of the tracks produced by recoil photons produced by the elastic scattering of the incident neutrons with a hydrogenous material (Polyethylene) or the film base. The track density is related to neutron exposure. The film is covered with a Cd filter to eliminate proton tracks produced by slow neutron reaction, 14N (n p) 14C. Counting of tracks is a tedious process and statistical errors are such the below 100 rems, the method is not very reliable.

1. Open Window
2. Plastic
3. Cadium (Cd)
4. Thin Copper (Cu) (Cu)
5. Thick Copper
6. Lead (pb)
7. Portable Survey Instruments



(a) **Ionization Chamber**-This is sometimes known as the gun monitor or the Multiparameter. This instrument is shaped like a pistol and has an ionization chamber made out of air equivalent materials such as bakerite or other material of low atomic number so that one may expect its readings in roentgens per hours to be relatively independent of the gamma photon energy. An electrometer valve circuit is provided. Gamma radiation falling on the chamber (assumed filled) with air at atmospheric pressure causes an ionization current to flow given by

$I = 0.92\ VR \times 10\text{-}^{10}$ amps

where V is the volume of the chamber and R is the radiation intensity in R/h. For use under normal circumstances, the ionization current is very low (10- to 10-1 amps). There is normally a thin window which when uncovered allows the passage of beta particles and thus permits monitoring of beta radiation. Refer page 352 for sketch.

(b) **Geiger-Muller Survey Meters**-This is most widely used. It is most useful for beta-gamma radiation detection but readings cannot be considered quantitative. These instruments are normally used for limitations are (i) it changes calibration and plateau characteristics with use, (ii) it jams on intense radiation field and probably reads zero instead of infinite, (iii) it has a limited lifetime of between 10^8 to 100^{10} counts, (iv) it is frequently photo sensitive so that shielding from direct light is essential, (v) it is thermally sensitive and (vi) it is energy dependent Refer page 352 for sketch.

(c) **Survey Meters for Alpha Particles-**For alpha particles measurement, it is usual to employ a scintillation counter comprising a ZnS screen, a light box. A window of aluminized mylar of about 0.7 mg/mm^2 thickness is used for passage of alpha particles. Each alpha particle striking the ZnS screen produces a scintillation which is magnified by the photomultiplier and subsequently counted in a count-rate meter.

ASSESSMENT OF SAFE LEVELS

8. Radiation doses are cumulative in effect the damage and symptoms however depend not only on dose but also on the rate of dose received each time. The effect of cumulative dose of radiation are as under:

(a) Below 150 centigray's	-	No long-term effect
(b) 150 to 450 centigray's	-	Incapacitation leading to possible death.
(c) 450 to 800 centigray's	-	Incapacitation and death in two weeks.
(d) Above 800 centigray's	-	Certain death.

PERSONAL PROTECTIVE EQUIPMENT

9. **Positive Pressure Self**

Contained Breathing Apparatus (PPSCBA)-This must be of "positive pressure" (PP) design. "Positive pressure" means that the SCHA constantly maintains a positive air pressure in the face mask which serves to prevent inward leakage of contaminants into the mask through the mask seal PPSCBA provide the highest level of respiratory protection against airborne contaminants and oxygen deficiency for personnel. Two types of PPSCBA are currently available They include open circuit SCBA and closed-circuit SCHA (or rebreather) The open circuit type supplies fresh air to the face-piece regulator from a compressed air cylinder worn on a backpack Exhaled air is discharged to atmosphere directly outside the face mask. The open circuit SCBA units weigh about 15 pounds and provide an average of either 30 or 45 minutes of breathing air supply (depending on the model) Workers under physical stress will consume the unit's rated air supply more rapidly. The closed circuit PPSCBA or rebreather recycles exhaled gases (Ns_2 CO_2 and O_2) and removes CO_2 by use of a disposable alkeline scrubber. Oxygen is replenished into the breathing air from a liquid oxygen (cryogenic) tank mounted on the unit's backpack. Some of the advantages a closed circuit PPSCRA has over an open circuit PPSCRA include:

(a) Operating time is much longer (up to four hours).
(b) Units are lighter (20-30) pounds.

10. Some of the disadvantages of a closed circuit PPSCRA include: -

(a) The unit's breathing hag must never be worn outside an encapsulating suit because the bag may be permeated by chemicals, contaminating the apparatus and the breathing air. Also, decontamination of the breathing bag may be impossible.

(b) At very cold temperatures, scrubber efficiency may be reduced and CO_2 breakthrough may occur.

(c) Heat that is normally exhaled by open circuit SCBAs and the heat generated in the CO_2 scrubber are retained in the unit possibly adding to the individual's heat stress.

(d) The units require much longer set up or donning time due to the handling and filling of cryogenic oxygen.

(e) The units are more expensive to operate and maintain.

11. **Positive Pressure Air**

Line Respirators (PPALR)-PPAIR units consists of a positive pressure face mask connected to an air-line (umbilical cord) which is tied into a remotely situated compressed air cylinder. The length of air-line is limited to NIOSII regulations to a maximum of 300 feet. The PPALR unit must be equipped with an escape SCBA provision that will provide immediate backup respiratory protection if the air-line should fail Some of the advantages that PPALR have over PPSCBA include: -

(a) Operating time is much longer than conventional open circuit PPSCBA.

(b) Since its air supply is not carried by a wearer, the PPAIR units are lightweight (approximately 15 pounds with escape SCBA provision).

12 **Some of the PPALR disadvantages include**.

(a) Since air-lines drag behind the wearer. it often becomes contaminated and may be subject to degradation.

(b) The air-line may impair personnel mobility and require that the wearer exit the area by retracing the exact route of entry.

(c) The supply ait cylinder level must be monitored by other personnel.

13. **Air Purifying Respirators (APR)**

APR (commonly called cartridge respirators) consist of a face-piece connected to an air purifying filter The filters are approved only remove a designated contaminant or contaminant category from the breathing air by adsorption, absorption, filtration, or chemical reaction. APR units are normally of negative pressure design. Canister filters are not available nor approved for use on many chemical air contaminants. When a canister filter is selected for use against gases or vapors, the filter can only be used if the chemical (s) have "adequate warning properties". Because most APR units are negative pressure design, OSHA requires all users of APR to be individually fit-tested for an adequate face mask seal Fit-testing is done in an odor-controlled environment and must be completed for all types or styles of APR marks that an individual may wear. The following conditions would prohibit the use of an APR:-

(a) Oxygen deficient atmosphere.

(b) Potential presence of unidentified contaminants.

(c) Concentration of contaminants exceeding the recommended canister use concentrations.

(d) High humidity (sometimes reduces canister's efficiency).

(e) Canister not specifically approved for a contaminant that is present.

(f) Individuals without excellent olfactory senses.

(g) Individuals that have not been fit-tested or trained in use of the respirator.

14. In general rescue teams use APR units only in areas where low concentrations of known contaminants exist. An example is in the decontamination zone. Workers and equipment leaving the exclusion zone are often decontaminated by support individuals wearing approved APR as respiratory protection. As a general rule PPSCBA is the respiratory protection device of choice of 99% in NBC environment.

RESCUE OPERATIONS

15. **Radioactive Area**

The radioactive fission products, in whatever from they are distributed on the ground, will emit radiation which could be harmful to people working in the area, if absorbed to excess. The human body can absorb a small dose of radiation daily for years without being affected in any way, but if large doses are taken at one time, radiation sickness may result. Rescue parties will be equipped with individual dosimeters and the function of these is to measure the amount of radiation which is user absorbs while operating in a contaminated area. By keeping a record of the dose sustained, it will be possible so to control the operational of the user as to ensure that he will not sustain such a total dose of radiation as to render him unfit for further operations in a radioactive area. Rescue parties have to go where they are needed. Therefore, it will be the responsibility of those in charge to see that personal dosimeters are checked periodically. Headquarters Section reconnaissance parties will be available in cases of doubt to give dose-rate measurements and confirm how long the parties can work in the area before acquiring the maximum permissible dose. In addition to the hazard from the external radiation, there is a possible hazard from the actual absorption of radioactive substances in the body, either through the skin or through the nose and mouth. The external radiation risk is, however, much greater in proportion, and as long as the safe working timers for this are adhered to, the risk from internal absorption is negligible. The wearing of respirators is not necessary, unless the dose of external radiation from contaminated ground is likely to exceed the maximum permissible dose. In such cases, a special warning will be given by the Headquarters Section reconnaissance parties. The observance of a strict working and cleansing discipline is always desirable: therefore, no food, drink, sweets, smoking materials etc, must be carried, owing to the danger of their contamination by fission products

16. **Contaminated Area Operation**

(a) **Nerve Gas**-At ground level, where ventilation is free and dispersion is rapid, nerve gas should not cause any serious inconveniences to rescue workers, provided they are equipped. with properly adjusted respirators. It must be remembered, however, that if gas penetrates into basements, cellars or under heavy debris where there is little air movement, it may persist for some time in. probably, dangerous concentrations. Under these conditions respirators will have to be worn for prolonged periods. and in view of the greater strain imposed on the men, the length of their spell of work imposed on the men, the length of their spell of work should be correspondingly reduced. When rescue men have to break into basements into which gas has not already penetrated great care must be taken to prevent the entry of gas This might be ensured in one of several ways, for example:

(i) By leaving the final act of breaking in until the gas has sufficiently dispersed, provided this is not too long and it is certain that it has not already penetrated the basement.

(ii) By rigging up a temporary gas-lock with wet blankets around the place where entry is to be made. This takes time and is not always practicable.

(b) **Mustard Gas**-The problem of mustard gas is, however, different because although the respirator will protect the nose, eye, breathing passages and lungs, exposure of the skin to vapour will cause injury and the effects will be more serious, if the exposure is prolonged or the concentration of vapour is high. If rescue work has to be carried out in a high concentration of mustard vapour it may be necessary for the Rescue Party to work in some form of protective clothing and respirators.

(c) **Fall Out**-The protection from fallout depends upon three factors ie. time, distance and screening: -

(i) **Time**- Radio-activity decays fast. It becomes 1/100 or its value within about 2 days, and therefore, if the fallout is likely to reach the area after about 2 days or so it would have already decayed possibly below harmful level.

(ii) **Distance**-From an uniformly contaminated area 1/3rd of the total dose comes from a radius of 12 ½ feet; half the total dose comes from a radius of 100 feet. If within these radii there are walls, obstructions or other buildings this dose will be reduced and hence it will be safest to be inside and safest inside a shelter or a trench possibly with overhead cover.

(iii) **Screening**- The screening provided by various materials in reducing the dose depends upon their density 22 inches of concrete reduces the dose by half another 22 inches to one fourth, and so on. 6 inches of concrete is equivalent to 7½ inches of brick or 9 inches of earth. Thus, in the centre of a two storied brick building it becomes one fortieth, in a slit trench with one foot earth overhead to one hundredth and in a basement shelter to two to three hundredth.

EFFECTS MONITORING OF AIR, WATER AND FOOD

17. In view of the fact that rescue parties are required to stay in depots mostly knowledge of radioactive substances likely to be inhaled/ingested. contamination of drinking water, and food stuffs is necessary.

18. **Effects**

(a) **Air**-Radioactive dust particles may be inhaled, of which those larger than I micron diameter are stopped in upper air passages whence they may find their way into the elementary tract. Smaller particles have a good chance of entering the lungs. Of these calcium, strontium, barium and tellurium which form soluble salts are absorbed into the blood circulation. Columbium, ruthenium, lanthanum, cerium and plutonium being less soluble are retained in the lungs where they may cause cancers of different local tissues.

(b) **Ingestion**-Radioactive substances are absorbed from the interior the same way as from lungs. Those absorbed in the blood circulation accumulate eventually in bones whence the rate of excretion is extremely slow. All these long-lived radioactive elements deposited in bones will injure not only the bones producing bone cancers but also the blood generation system producing anaemia and blood cancers. Radioactive plutonium concentrates in liver producing liver degeneration.

(c) **Effect of Fallout on Sources of Drinking Water**-Gamma radiation does not in any way affect the purity or impair the potability of water. The main purpose of the monitoring organisation would be to prevent the water from transporting radioactive matter in the body underground sources would in general remain in free from contamination. The fused and semi fused particles as well as the larger particles of earth, sand and dust would sink to the bottom of a river or reservoir and only soluble radioactive matter held loosely on the surface of the particles would dissolve and slowly diffuse into the bulk of water. It is reasonable 10 expect that the flowing river water would not be contaminated above emergency levels for long period. The large surface areas of impounding reservoirs are open to fallout and their water can therefore be contaminated to dangerous levels.

(d) **Effects on Food Stocks**-Gamma radiation has no harmful effects on foods generally. Neutron bombardment might induce some radioactivity. But this would not occur outside the area of complete destruction and by the time such food could be salvaged it would be safe for consumption. Radioactive fallout depositing on food may however, find way into the human body. The effect of fallout on the crops.

19. **Monitoring**

(a) **Air Monitor-**As indicated earlier, particulate radio-contaminants in air can lead to inhalation or ingestion hazard. To ascertain the level of this form of contamination, air is sampled by drawing it through a special high-efficiency filter paper which traps and retains a high proportion of the particulate matter. The filter paper is generally in the form of a disc about 2 inches in diameter which is held by a quick-release ring fitting on the end of the suction pipe: an open mesh wire grid at the back of the paper supports it and prevents it from being pulled or torn by the air pressure. The pump used is a form of a domestic vacuum cleaner. Refer page 352 for sketch.

(b) **Installed Air Monitors**-The pump, the air through the may be sited in any convenient place. The design of the pump should be such that it will maintain a satisfactory air flow against the back pressure which increases steadily as the dust layers build up on the filter. The flow rate will, however, fall because of this dust loading. In order to measure the quantity of air which has been sampled, an integrating anemometer is therefore fitted close behind the filter paper with a side window through which the recording dials can be read. The installed monitors should be run continuously. Changing and assaying of the filter paper should be done regularly, the frequency depending upon the dust loading in the air. They should not be left so long that the air flow is seriously diminished by the build-up of dust on the paper.

(c) **Portable Air Monitors**-Their pump is similar to a cylinder type vacuum cleaner with the head containing the sampling and flow measuring equipment fitted to the suction end. For certain applications the filter paper holder may be attached to the end of a length of flexible hose so that it can sample at positions where it would not be convenient to have the more bulky equipment. Such an extension head can, for example, be held close to the face of a worker in order to make a good evaluation of the actual contamination breathed during an operation. The paper should. however, be fitted at the remote end of the hose.

(d) Food and Water Monitoring-Potentially contaminated supplied of food and water should be monitored to determine if they are acceptable for human consumption in the following way:

(i) Use an available, appropriate monitor.

(ii) Check the operability of the instrument.

(iii) Select an area that is shielded so that the meter indication is as low as possible. Since the space required to conduct this type of monitoring will be small, it should not be difficult to improvise a shielded area if needed. Determine the background radiation.

(iv) Monitor the food or water at a distance of approximately one inch from its surface, with the probe shield open.

(v) Observe the meter indication. If it increases above background. contamination is present. Do not discard contaminated food or water. It should be decontaminated and rechecked, or placed in storage and rechecked at a later date for possible consumption after the contamination has decreased due to radioactive decay. Foods such as fruits and vegetables could be decontaminated by washing brushing or peeling. Water which is heavily contaminated may be improved by sedimentation and filtering. If only contaminated food or water is available, the monitor should determine which portions are least contaminated. If its use becomes necessary, the monitor should recommend that the supplies with the smallest amount of contamination should be used first.

(e) **Growing Crops**-Crops contaminated with radioactive dust will need careful handling to prevent the transfer of radioactive matter to the skin, hair or clothing and thence into the mouth or into cuts abrasions. Root crops should be fir after thorough washing and so should peas and beans in the pods. Of the pods were washed before and the peas after shelling. The hearts of cabbage, sprouts and lettuce should be thoroughly washed after discarding the outer leaves. Leafy vegetables once contaminated should be discarded and buried in the ground. Not to be given to animals even. Hard skin-fruits could be washed and peeled but soft fruits should be discarded. Flour produced from cereal contaminated with fallout contains only a small fraction of the original contamination. The effect of fallout on crops depends upon their state of growth at the time. Those in early stages of growth absorb radioactive matter through the root system in addition to being contaminated by the fallout on the other parts of the plant above the ground. In the ground, the fallout contaminants de not go deep and are retained in the top few inches only. It is advantageous to dig or plough them deep and then add lime in the lime deficient soil. This will prevent the uptake of radioactive strontium by plants.

(f) **Livestock**-Livestock are affected by the initial as well as the fallout radiation in the same way as human-beings are. The flesh of the animals exposed this way is fit for human consumption provided the bones and offal are discarded, unless they are in the last stages of radiation illness. Where possible, animals should be put under cover and fed with clean food and water, priority being given to breeding stock and dairy cattle.

(g) **Milk and Eggs-**Cattle, grazing in the open, will take up and excrete considerable properties of radio-iodine and strontium in milk which will be unsafe for infants fed entirely on milk Convert this milk in butter and cheese and then store them until the radioactivity decays to safety levels, or in the last resort, feed it to animals e.g. pigs and poultry. Eggs are not generally contaminated to a serious extent and some risk may have to be accepted when food is in short supply. In doubtful cases when poultry are known to have taken heavily contaminated feeds, the eggs could be preserved and stored until they could be tested for radioactive content

20. **Conclusion**

Radioactive dust floating in the air or that settling down on the food and water can be a source of dangerous internal radiation in the course of the radioactive fallout following nuclear explosions. The same dust deposited on the surroundings or the clothes and the skin can poss serious problems of external radiation. It is imperative therefore, to monitor the air before coming in the open for routine work or consumption of food and water to detect the dangerous radio contamination, to be able to avoid or decontaminate them to prevent external or the internal radiation hazards. Use of the appropriate monitoring devices and techniques should, therefore, be made.

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CHAPTER 19

RESCUE FROM FLOODS

1. **Introduction -**Flooding can result from any accumulation or rise of water on land areas like river floods, hurricanes and storm surges. In popular usage, river flood describes an overflow of water onto normally dry land. More professionally, hydrologists consider a river to be in flood when its waters have risen to an elevation at which damage can occur in the absence of protective works. Flash floods are a fact of life-and-death-along the river's streambeds, and arroyos of India. These floods result when rain fills natural and man-made drainage systems to overflowing with water, carrying along with it uprooted trees, smashed structures boulders, mud and other debris.

2. The king of disastrous weather is a hurricane; no other natural storm can match its size. intensity, duration and destruction. A hurricane may last several days and ravage hundreds of square miles (square kilo meters) of densely populated coastal regions. Coupled with the destructive winds of a hurricane are some killers: storm surges that combine with astronomically high tides to smash several hundred yards (meters) inland: killer tornadoes the spin off from the walls of thunderclouds that are pushed in front of the hurricane, and torrential rains that flood areas hundreds of miles from the coast.

3. The survival techniques described in this chapter could form the basis of education and training programme conducted by emergency rescue personnel in the interests to promoting public safety. If recovery of the victim is prompt and proper resuscitation measures taken, many lives may be saved. In any flood situation. the alertness and preparedness of the rescuer is essential.

CAUSES OF FLOODS

4. The usual sources of excess water within the watersheds of a river are abnormally heavy rainfall or runoff from large accumulations of packed snow. A cause of serious flooding in the lower reaches of larger rivers is the concurrent arrival of flood crests from major tributaries. As stated, earlier formation of low-pressure area over the seas leads to hurricanes and its associated killers like heavy rains, tidal waves and high velocity winds. All combined lead to destruction of life and property.

5. Inadequate protective measure by the Government in flood prone and hurricane prone area can also be considered as the cause of floods and resultant destruction. Certainly, the effects of the natural disaster can be mitigated and controlled by long- and short-term measures.

TYPES OF FLOODS

6. Floods are of two types: those that develop and crest over a period of some twelve hours or more, and those that develop suddenly and crest within several hours or even minutes. The warnings time varies by type and location of flooding.

The amount of warning has a direct relationship to the emergency measures that can be taken. With little warning, it may be possible only to evacuate people to high ground. With longer warning property can be evacuated or protected and emergency engineering protective works can be constructed.

7. Flash flood waves, moving at incredible speeds, can roll boulders, tear out trees, destroy buildings and bridges, and scour out new channels. Killing walls of water can reach 10 to 20 feet (3 to 6 meters) high. There will often be insufficient warning that these deadly, sudden floods are coming since heavy rainfall, even for short periods of time, may be followed by flash flooding in mountainous or hilly areas

EFFECTS OF FLOODS

8. **Primary Effects**-The immediate or primary effects of Bloods result from inundation and the force of currents. Residents and livestock may be drowned, displaced or injured by the floodwaters and the current-borne debris. Swift currents and debris cause structural damage to homes, buildings, highways, railroads and bridges. Sanitary, electrical, water and telephone installations are damaged. Business inventories and personal belongings are lost or damaged. Crops and plants are carried away by currents or destroyed by inundation. Farms can lose stored feed, equipment and buildings. Farmlands may be deeply eroded by new channels or lose areas of valuable topsoil and vegetation. The dislocations and disruptions caused by a flood lead to hunger and disease among the affected population. Many people are left homeless. Obstructed transportation and communications can force evacuation of homes and separation of families. Health hazards are increased or created. Water may be contaminated through damage to water and sanitary systems. Wild animals and snake may be driven into inhabited areas: rats, when forced from their regular habitat, can cause particularly serious health problems.

9. **Secondary Effects**-The force and depth of flood waters can cause disruptions and malfunctioning's which in turn cause further damage or hazard. For example, short-term pollution of a river can be caused by chemicals released when a flood engulfs warehouses or other container. Electrical fires can be caused by short circuits, and fire hazard can result from broken gas mains. These hazards are minimized or avoided by timely preventive measures.

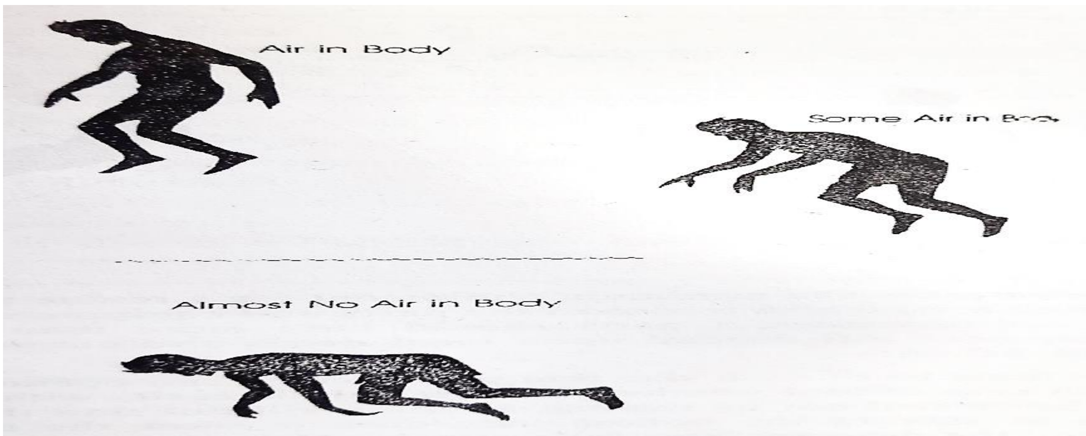
10. **Effects of Hurricanes**-A developed hurricane is a vast whirlwind of extra ordinary violence. Such storms vary from 25 to 600 miles (40 to 960 kilo meters) in diameter. As the axis of the hurricane passes over a given spot, the wind marches a maximum velocity in one direction, diminishes to calm, and then increases to maximum force in the opposite direction. The destructive forces in a hurricane grow rapidly with increased intensity. A 160 miles (256 Kilo meters) per hour wind is not merely twice as strong as an 80 miles (128 Kilo meters) per hour gale. If the wind doubles in velocity, the pressure exerted will be in proportion to the square of the difference. When the velocity doubles, the pressure will increase four times; when the velocity triples, the pressure will increase nine tires. An 80 miles (128 Kilo meters) per hour wind can unroof buildings and down large trees. When 160 miles (256 Kilo meters) per hour winds blow, carrying with them trillions of tons of water, the appalling forces unleashed are almost unbelievable. Another phenomenon accompanying a hurricane is the Blooding of shorelines in its path. This results from the effect of the wind on the water over which it moves. Within the eye is a barometric low pressure, which, with the wind action, causes a water level rise of approximately 1 foot (0.3 meter) for each 1 inch (2.5 centimetres) drop of the barometer. If this action occurs simultaneously with the normal high tide, a disastrously extra-high tide can result.

RESCUE TECHNIQUES

11. **General**-The basic principle of water rescue operations is that as long as there is the slightest possibility that the victim of an underwater accident is still alive, no effort should be spared to accelerate rescue. Unfortunately, many rescue operations are merely body recovery efforts due to delay in finding the victim. Artificial respiration should be started immediately upon recovery of the body, unless it is definitely known that the victim has been under water continuously for a great length of time. Resuscitation must be continued until the victim is either revived or pronounced dead by a physician.

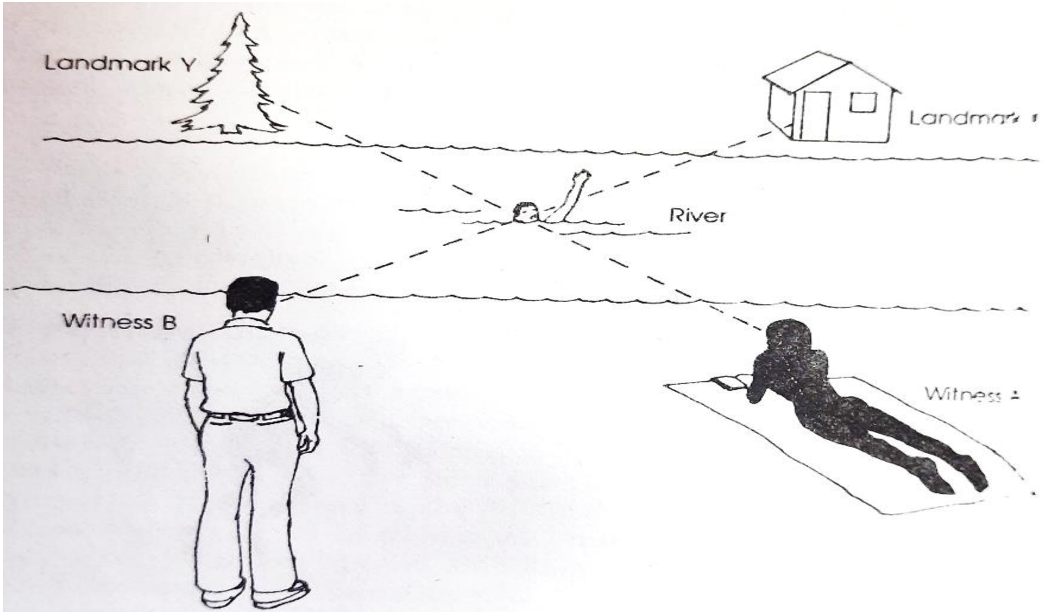
SEARCH AND RECOVERY

12. (a) **Buoyancy of Body**-The average body has about the specific gravity of water. This means that the body will displace its own volume of water and the volume of water displaced will weigh about the same amount as the body. Therefore, the average body will almost float: sometimes bodies of victims who are fat and bodies of small children do not sink, but remain floating on the surface. As long as the body is totally submerged in the water, it will weigh approximately 1 pound (0.45 kilogram); for this reason, heavy tackle is not needed to make a recovery. The slightest hook in the clothes or body will bring it to the surface provided gentle pressure is used and the hook is not torn out. When a person falls into the water, the momentum of the fall will make the body sink. The victim will be holding some air in the longs, and there will be some trapped in their clothes instinctive swimming movements will bring the victim back to the surface. Some may gasp, take in air and water, and sink again; this cycle may be repeated until they finally sink to the bottom. The position of the body in the water largely depends upon the amount of water in the lungs and stomach. In approximately 10 per cent of the drowning cases there is little water or no water in the lungs in such cases, the body will be in an almost upright position. With less air in the lungs and stomach, the body will be in a crouched position, and with almost no air in the body it will be in a crawling position. Refer figure below. A body will rise slowly to the surface when sufficient gas is formed in the intestinal tract to make the body buoyant, this gas is the result of bacterial decomposition. The time necessary to generate the necessary gas will depend upon the temperature of the water and contents of the victim's stomach when drowned. In summer, the average time is 18 to 24 hours. In winter, or when the water is very deep and cold, die time will he much longer. A body will not rise suddenly from the bottom, but rises gradually as more gas is formed and the body becomes buoyant.



The position of the body in water largely depends upon the amount of water in the lungs and stomach

(b) **Location of Bodies**-A body will usually remain in the general area where it submerged and will likely be found within 25 to 50 feet (7.5 to 15 meters) of the location. Even with a strong current. it will probably be found within 100 to 150 yards (90 to 135 meters) of where it went down. It has been established that the average body under average conditions will be within one and one-half times the depth of the water, for example, if the water is 20 feet (6 meters) deep the body will probably be found within 30 feet (9 meters) of where it went down. Opportunity for quick body recovery may depend upon accurately determining the exact location where the victim disappeared. Where a current exists. a body may drift to the first eddy or deep hole, depending upon the force of the current and obstructions on the bottom. If the body is floating, it may hang up on some obstruction down current or downstream. If a recovery operation has sufficient manpower available at the scene, it is good policy to dispatch personnel down current on the chance that the body was floating When a rescue party arrives at the scene immediately after submersion and the water is very calm, the victim may be located by a thin stream of air bubbles coming from the body. These bubbles are caused by water pressure on the chest and abdomen forcing out the air remaining in the body. Even under these circumstances, the body may be 10 to 12 feet (3 to 3.6 meters) from the spot where the bubbles are breaking the surface of the water. Other things can give off similar streams of air bubbles, but any such leads should be checked out. A simple method thus to locate a body is explained in figure below A witness at POINT-A saw victim in line with TREE. Similarly a witness at POINT-B saw victim in line with LANDMARK The body will be near the place where line AY cross line BX.



(c) **Rescue Party Equipment**-The minimum equipment for a rescue party is a boat, life jackets, oars, drag hooks, ropes, and a vehicle to transport the party and equipment to the scene. For efficient operation under varied circumstances, a party should have more than the bare minimum. The amount and type of equipment will depend upon local needs and circumstances. Details of these equipment are explained below:

(i) **Boat**-The boat must be of such size that two rescuers can operate it safely and yet be able to reach shore in case of foul weather. It must handle easily with cars since most dragging operations will be carried out by rowing: a motor will not slow down sufficiently to permit the drag hooks to sink to the bottom. nor does it allow the operator to stop the boat immediately when the drag operator feels a strike. However, there should be a motor on the boat that has sufficient power to get the crew to the scene of operations and to operate the boat in stormy weather. All personnel in the boat should wear life jackets at all times.

(ii) **Drags**-There are many types and styles of drag hooks now in use by rescue party and there is considerable difference of opinion as to which type is best to use. Because of the large variety of conditions that may be encountered in different localities, all commercial types should be considered and the models selected that best suit the anticipated situations. In the selections of a type or style of drag it is well to remember that the body is usually on the bottom in a position which may be anywhere between crouching and upright. The body will weigh about 1 pound (0.45 kilogram) as long as it is fully submerged; therefore, heavy tackle is not needed to make a recovery, A drag that will sink. sweep along the bottom, and lift about 1 pound (0.45 kilogram) is sufficient. A 5 or 6 feet (1.5 to 1.8 meters) long tower with treble hooks spaced along it makes an efficient drag. A large four-way hook attached is a pole is excellent for areas which are filled with rock, stumps or other obstructions. It can be used in water upto 25 feet (7.5 meters) deep and is relatively easy to use when the handle is joined in 4 feet (1.2 meter) sections. It is used in an up and down tamping motion over the search area. The hook can be used to secure a body when it is near the surface or alter it has been booked by light drags.

(i) **Boys and Markers**-A sufficient number of buoys and markers, or other floats, complete with anchors and anchor lines should be carried to mark the area of operation adequately.

(ii) **Out Board Motor**-It is a machine which is used for rowing boats and rafts during rough weather or in rivers with current more than 3 knots. Basically, the OBMs are available in four types: -

(aa) 4.5 HP Johnson Sea Horse
(ab) 9.8 HP -do-
(ac) 22 HP -do-
(ad) 50 HP Rude Sea Horse

The table showing comparative characteristics of each is given below. All OBMs are fitted with special brackets in order to facilitate their installation on various types of boats. OBMs can be fined in Assault Boat Storm Boat Recce Boats or Folding Boats. The following safety precautions may be followed while using OBM:

(aa) Ensure complete safety stores are available in the boat should the OBM fail.

(ab) Always lash OBM with boat.

(ac) Tilt: 0BM when boat nears the shore.

(ad) Use correct oil mixture.

(ae) Do not start OBM outside the water.

(af) Drain fuel tank after use.

(ag) Do not panic should the OBM stop functioning in fast currents.

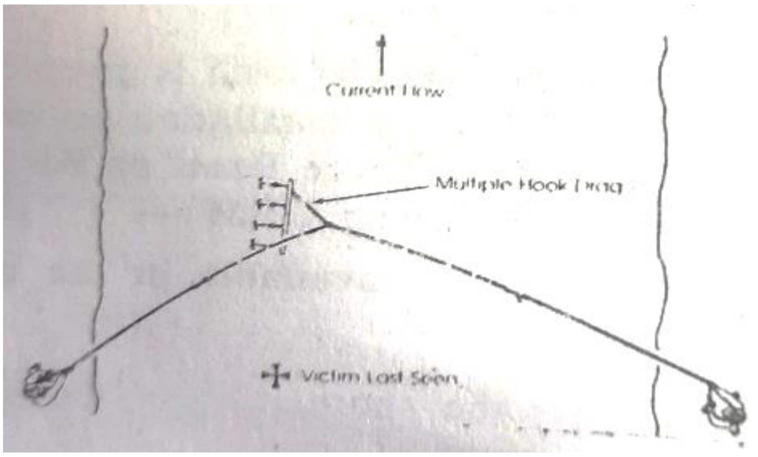
Note-refer Appendix for operating procedure with OBM.

No.	Item	9.8 HP	22 HP	50 HP
1.	Make	Johnson	Johnson	Evinrude
2.	Weight	64	109	198
3.	Cylinders	2	2	4
4.	Cylinders Bore (inches)	2 $^1/_8$	2 ¾	2 ¾
5.	RPM	4000	4000	5500
6.	Fuel	White petrol	White petrol	White petrol
7.	Lubricating Oil	SAE 40	SAB 40	SAB 50
8.	Fuel: Oil	8:1	8:1	8:1
9.	Fuel Tank	13	20	22
10.	Capacity (Pint) Max height of stern	21”	21”	

(d) **Search and Drag Techniques**-On arrival at the scene of a drowning, the rescue party leader mast first determine as accurately as possible the exact point where the victim submerged. A marker buoy should then be set at this location and other floats of another colour set approximately 50 to 100 bet (15 in 30 meters) in all four directions from the marker buoy. When the area of operating is so marked, then the method or technique necessary to make a recovery can be determined. Some of the methods of search and drag techniques are explained below:

(i) **Shallow Water Search**-It would be foolish to launch a boat and attempt to drag a body of water that is only 3 or 4 feet (1 to 1.2 meters) deep. A recovery could be quickly made by rescuers lining up shoulder to shoulder and shuffling across to the other side then returning areas of search should overlap the previous search path. It is well to set up a guide rope so that the party will be positive of the search area and no part of the bottom will be missed. An exception may be made in cold weather when it would be a risk to the health of the personnel to get into the cold water without protective clothing.

(ii) **Shore to Shore Grappling**-In flowing water a body may be carried with the current for short distance; the dragging operation should start downstream from where the victim was last seen. The rope length should be over twice the width of the area to be covered and the drag secured to the centre of the rope. The rescue crews will take positions on opposite banks of the stream and slowly pull the hooks across the area. If nothing is hooked, the crew should move upstream a distance equal to one-half the width of the drag and pull the drag back across. This procedure should be continued until the entire area is covered, and then reversed so the area is covered twice. If the body is not then recovered, the search areas should be extended in both directions and the procedure repeated.



(iii) **Beat to Shore Grappling**-This method is similar to shore to shore grappling, except that one crew is on shore and the other crew is on an anchored boat. The crew on shore should move along the shore after each drag for some distance, then the boat should be moved reanchored, and the operation repeated.

(iv) **Boat to Boat Grappling-**This procedure is similar to shore to shore grappling: two boats should be anchored both bow and stern and facing in the same direction.

(v) **Grappling from a Moving Boat**-The least advantageous method of dragging for a drowned person is from a moving boat since movements cannot be controlled perfectly, the entire bottom may not be thoroughly covered. However, dragging from a boat is the principle means of recovering bodies from large, deep lakes and rivers. Untrained volunteers often place the most powerful motor that they can obtain on the largest boat and race back and forth in the area; they usually work for hours and have nothing to show for their efforts. It must be kept in mind that a body submerged in water weighs approximately 1 pound (0.45 kilogram) and is resting on the bottom, therefore, the grappling hooks must sink to the bottom, if they are to make a strike. Fast movements will not permit the hooks to stay down where they can make a solid contact if they hit the victim's body. Examination of many drowned persons shows that the body was hit many times with the drag hooks, but the hooks were moving so fast and with such force that they only slashed the body and did not remain fastened.

(vi) **Use of OBM**-A motor may be used in rough water. It is best to utilize the motor to power the boat upstream with the hooks out of the water. Then allow the boat to float slowly downstream with the hooks on the bottom. If there is no current, rowing into the wind will give the oarsman the best chance to keep the boat on a straight course.

(vii) Use of Markers/Buoys-Buoys and Boats should be used to establish the body locations as nearly as possible. If there is no recovery within one hour, expand the search area and continue systematic dragging operations. Always be sure that each drag sweep the one just completed Additional markers dropped at the end of each sweep will give a positive indication of the area which has been covered, When a number of boats are in use, the boats should form a V-formation and make sweeps in the same manner as is recommended for one boat. Special care must be taken to see that each drag path overlaps the one next to and ahead of it. Where there is a current, drop a bag of old clothes or other such material into the water, placing a weight in the bag so that it will sink, and attaching it to a float so that it will be suspended a foot or two off the bottom. Place this bundle in the water where the victims was last seen. Follow the float and drop markers along the path that is established; this route should be followed with the grappling hooks. It is most probable that the body will be found in the first eddy or deep hole where the marker stops.

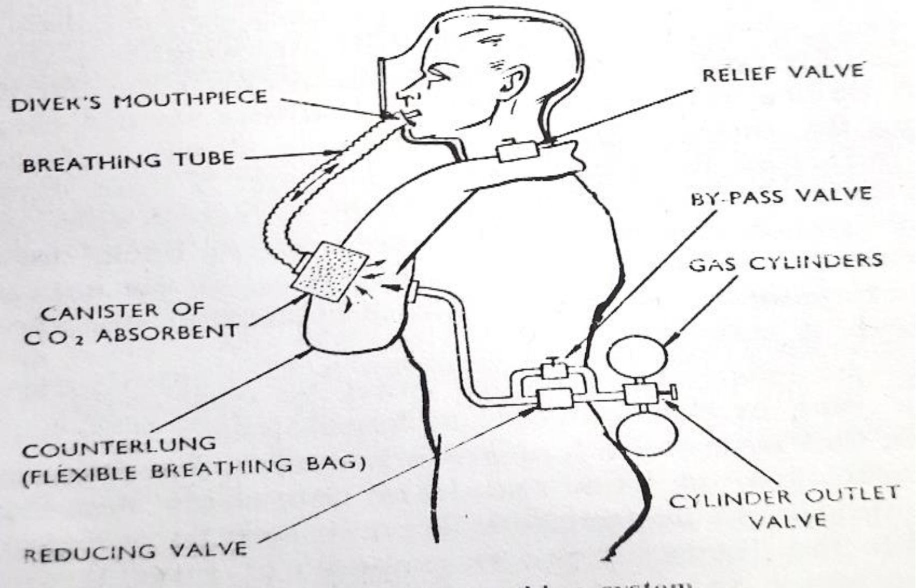
(viii) **Search by Pole Hook**-If the bottom is rocky, or full of the stumps and brush it is impossible to drag and the use of a pike pole hook is recommended. This type of grappling hook is usually constructed so that it may be extended by adding four foot sections of handle until a length of 20 to 25 feet (6 to 7.5 meters) is obtained. The pole should he held in a vertical position and the bottom tamped with quick up and down strokes. This probing action enables the operator to determine what is being struck by the bottom end of the pole. and lessens the possibility of the hook becoming fouled with debris on the bottom. The boat should be rowed slowly so the area can be thoroughly covered. When the body is located, the boat must be stopped and held stationary until the body has been securely hooked and raised to the surface.

SEARCH AND RECOVERY BY DIVING

13. **General**-In many areas skin divers can be used to make rapid recoveries of drowning victims. Only experienced divers should be used. All rescue divers should be certified by competent authorities as to their ability before they are assigned and permitted to dive on an emergency assignment. Divers must be coordinated in their efforts. Recovery diving in murky water is very hazardous. Water in a harbour that contains many boats has a layer of black oily silt which may vary in depth from a few inches to 4 to 5 feet (1.2 to 1.5 meters). The silt is easily disturbed, causing a loss of visibility. Behind dams where there was originally a river bottom, or in a rock quarry, the bottom is generally filled with trees, grass and moss that grew among the obstructions when the water was at a lower level. This vegetation will hang up a diver's air tank and face plate. Many times, these bodies of water are murky even though they are quiet. In such a situation, it is best to use the maximum number of divers and make a few sweeps as possible, keeping hand to hand contact if possible.

14. **Equipment**

(a) **Scuba Gear**-In this apparatus the breathing gas, which may be either pure oxygen or an oxygen-nitrogen mixture, is stored in cylinders at high pressure so that it occupies a reasonably small volume. When the cylinder outlet valve is opened the gas flows through a reducing valve, which supplies a constant mass flow irrespective of depth, into a flexible breathing bag or counter lung



Closed-circuit breathing system.

positioned on the diver's chest at the approximate level of his lungs. The diver breathes the gas from the counter lung via a canister of carbon-dioxide absorbent and a breathing tube. When the diver exhales, his expired breath passes back into the counter lung through the carbon-dioxide absorbent which removes the expired carbon-dioxide but has no effect on the oxygen and nitrogen. By breathing in and out of the flexible counter lung positioned level with his lungs the diver can health comfortably at any depth, as the counter lung is subjected to the water pressure at the diver's dep and the breathing gas in the countering and in the diver's, lungs will be at approximately the pressure as that on the chest walls. If more gas was supplied than the liver could use and there was no other outlet for the excess gas, the counter lung would fill up and eventually it would be impossible for the diver to exhale against the excess pressure in the counter lung, which would soon but. The same thing would happen when the diver ascended, because of the expansion of the gas is counter lung with the external reduction of pressure. To prevent this, a relief valve is fitted in the counter lung. The valve is normally held closed by a light spring and the external water pressure. The valve lifts when the pressure in the counter lung is slightly above that of the spring plus water pressure.

(b) **Inflatable Safety Vest**-An inflatable safety vest should be worn by each diver to floatation in case of emergency.

(c) **Emergency Knife**-An efficient knife should always be carried in an accessible location in case the diver becomes entangled in underwater debris.

(d) **Surface Floats**-These markers should be painted in a distinctive colour maximum visibility.

(e) **Anchors and Bottom Guidelines**-Anchors should be heavy enough or so designed that the lines will be secured to the bottom without drifting Guidelines should be thin enough so that they will not have much resistance when pulled through the water, and yet strong enough to be stretched taut.

(f) **Safety Lines**-A light strong line should be attached to each diver, unless diving takes plate in waters containing entangling debris.

(g) **Buddy Lines**-A short buddy line fastened to the SCUBA harness may be gripped by adjacent divers when during in murky water; this will allow equal spacing.

(h) **Underwater Lights**-In most night diving operations, underwater lights or flares are essential.

15. **Process of Diving**

(a) **Preparations**- If several divers are to participate in a search, each should understand exactly what the other members are supposed to do. With this information, a minimum of communication is needed under the water. All divers must operate in pairs (the buddy system) if maximum safety is to be obtained; this rule should not be deviated from unless an extraordinary circumstance prevents it Two persons will work as a team and will be responsible for each other's safety, Visual or touch contact should be maintained at all times while in the water. Divers should attach sufficient weights to their belts so that they will sink easily with a full air tank. Each member should check the partner's equipment before entering the water. Before entering the water, all divers should clear their ears by holding the nostrils closing the mouth tightly, and blowing slowly and moderately until the ears a clear, this is indicated by a popping of the ears. If both ears cannot be cleared by this procedure the diver should not try to force them. Neo synephrine solution, other nose dips may be placed in each nostril with the head hanging back the diver should remain in this position 20 seconds, taking long slow inhalations. If the ears still do not clear easily, the process may be repeated. If both ears cannot be cleared, one should not dive except as a last resort to perform a rescue.

(b**) Diving Tenders**: - At least one member must be constantly stationed at the edge of the shoreline, wharf, pier or boat gunwale to handle safety lines and serve as a tender for each team working in the water. Tenders are responsible for relaying communication between divers and supporting units. They should be constantly alert for hazardous conditions and must no leave the divers unattended. Tender should maintain traffic control within the immediate area so the divers are not endangered by boat or strong propeller currents. It is important to maintain an open space around the diving area.

(c) **Diving Operations**-When possible, the buddy system should be adhered to with two divers working together as a team. When the search area is small, or one diver is experiencing car trouble, one diver may descend alone. When there is a single diver in the water there should be another diver on standby prepared to dive if needed. In murky water, each diver should maintain contact with the partner by either harness or a buddy line or they may hold hands. Care must be taken to avoid fouling fins, harness, or air tanks on underwater obstructions. A diver who becomes entangled should remain calm and attempt disengagement in a slow and deliberate manner. Divers should always back out of narrow or obstructed area on the assumption that the way in was clear. Everything possible should be done to prevent disturbing the bottom and stirring up the silt. Divers should not tread water is a vertical position when near the bottom or touch the bottom with the hands, fins, or body any more than absolutely necessary. It is beneficial to keep a record of the areas covered in the search and the teams covered them. In the event of two- or three-day operations, a log of this type helps to prevent needless dives in areas already searched. When a search operation has been completed, a brief critique should be held to make notes of the operation for further reference. Information about currents and bottom conditions may prove beneficial if future dives are necessary in that area.

16. **Under Water Search**-A search is generally conducted by divers swimming in a definite pattern. Different patterns may be better suited to one type of search than to others; this will depend upon the type of the bottom, depth of water and the base of operations. Several search techniques are listed; an imaginative combination of two or three of these patterns will prove effective in almost any instance.

(a) **Types of Search**

Search by divers may be conducted:

(i) **Visual Search**-A minimum of three feet visibility is necessary for an effective visual search. Stop above the bottom, turn in a complete 360-degree circle slowly, and visually scan the area. Then swim a search pattern by keeping well above the bottom, but within visual range. The search interval should be less than twice the visibility limits. Swim, continuously scanning from side to side, at a speed calculated to give complete visual coverage. A compass may be utilized when visibility is good; a search line should be used when visibility is poor.

(ii) **Contact Search**-Contact searching is used when conditions of little or no visibility are encountered. The diver should descend to the bottom and search with the hands and arms. The search interval should be somewhat less than an arm span (usually 5 feet or 1.5 metres). The diver should propel forward at a speed calculated to give sufficient time to check the area by simultaneously sweeping half circles ahead and to the side with both hands.

(b) **Search Patterns**

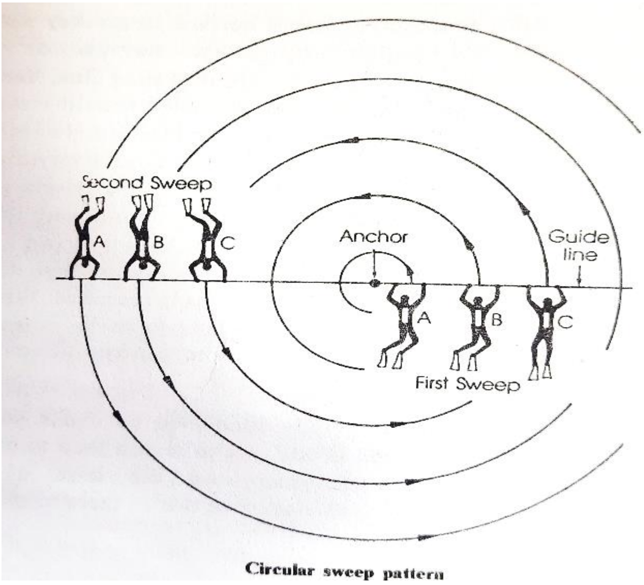
(i**) Circular Sweep Pattern-**The circular search pattern can be participated in by any number of divers, yet is effective for a single diver. The number of circles made from one reference point is determined by length of the guideline:

(aa) Place the anchor, which is attached to the guideline, in the centre of the area to be searched.

(ab) Space the divers along the line, starting close, to the anchor at a distance permitted by the visibility of the water.

(ac) Divers should keep abreast and slowly swim in a full circle they should keep the guideline taut.

(ad) When a 360-degree sweep has been completed the diver farthest from the anchor remains in position and the other divers take their places beyond that person on the line and swim another circle. It is important that one diver remain in position; otherwise, the area covered by the first circle will not be known and the object of the search might be missed.



Circular sweep pattern

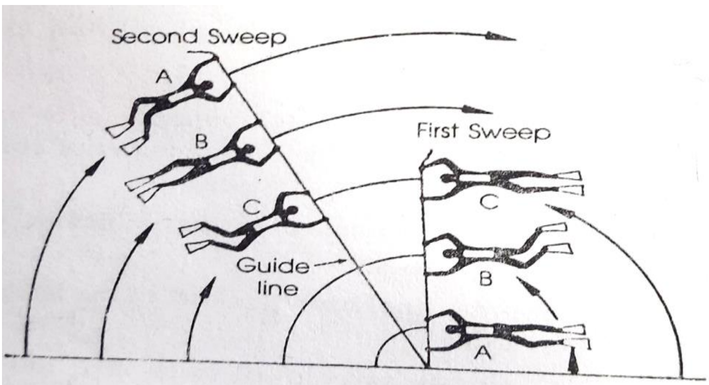
(ii) **Semi-circular Sweep Pattern**-The semi-circular sweep pattern is most effectively conducted from a wharf or a shoreline. The number of sweeps made from one reference point is determined by the length of the guideline:

(aa) Tie the guideline near the bottom of a wharf piling or anchor it on the shore.

(ab) Space the divers alone the line, starting close to the anchorage at a distance permitted by the visibility of the water.

(ac) The divers should keep abreast and slowly swim in a semicircle, keeping the guideline taut.

(ad) When a 180-degree sweep has been completed the diver farthest from the anchorage remains in position; the other divers take their places beyond that member on the line and swim a second semicircle. It is important that one diver remains in position; otherwise, the area covered by the first semicircle will not be known and the object of the search might be missed.



What, Pier or shoreline

(iii) **Straight Sweep Search Pattern**-The straight sweep from a single guideline is generally used when there are many divers participating in the search and a good visibility exists:

(aa) Place the anchor considerably beyond where the object of the search is thought to be.

(ab) Pull the baseline taut and fasten it to the shore.

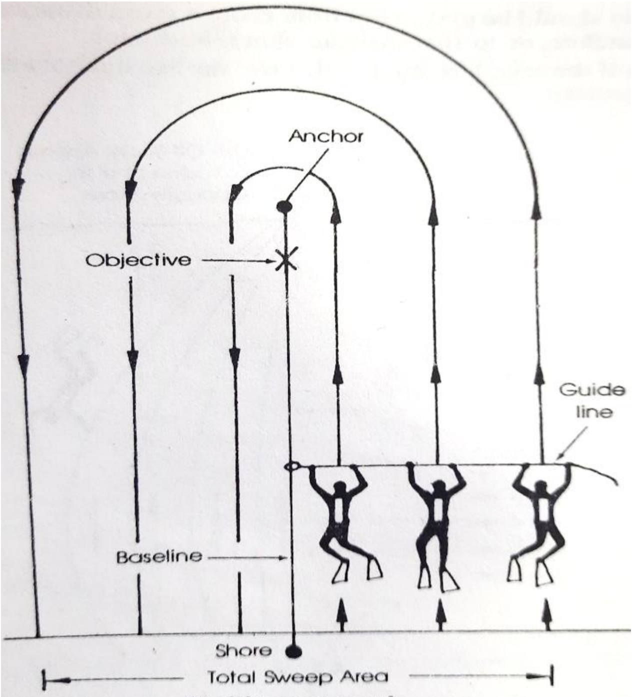
(ac) Attach a short line to be baseline with a loop. The length of this guideline will depend upon the number of divers utilized.

(ad) The divers should grasp the guideline and swim abreast until they reach the anchor.

(ae) The divers will then swim a 180 degree are so that they end up headed toward shore.

(af) When the divers are again abreast of each other, they will swim toward the shore.

(ag) If the object of the search has not been found, the baseline may be moved to a new location.



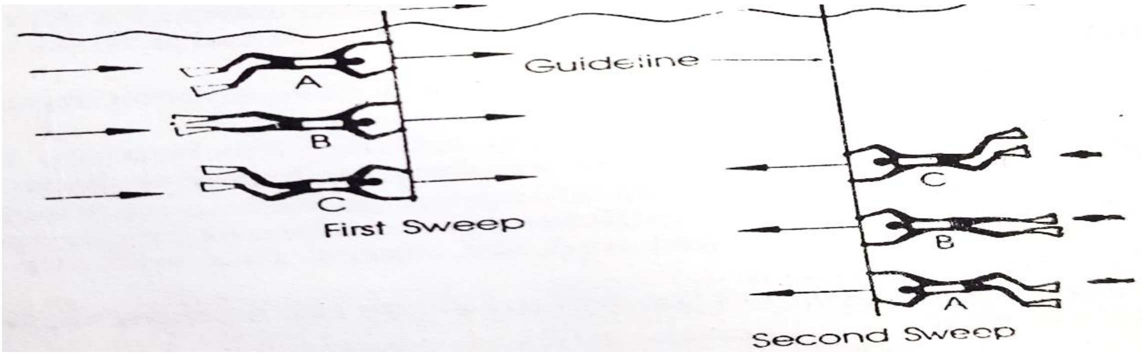
Straight sweep search

(iv) **Straight Sweep Along a Shoreline**-An effective method of searching a quiet body of water such as a lake or a pond is to have the divers spaced along a guideline. This type of search is effective when searching for small children who have drowned since they will generally be close to shore

(aa) Space the divers along the guideline at the distance permitted by the visibility.

(ab) The guideline is held by one man on the shore who walks along the edge of the water with the divers as they search; the divers should keep abreast of each other.

(ac) If the object is not found, the last diver should hold position and the other divers will take a position farther out on guideline for another sweep.



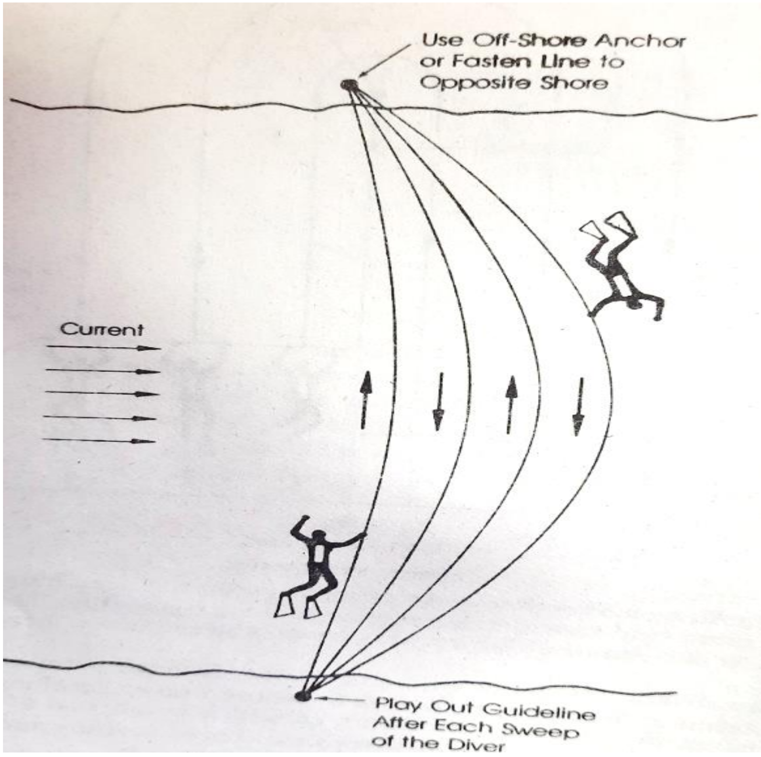
(v) **Straight Sweep in Current**-The straight sweep may be used in locations where there is current in one direction. It is difficult to use more than one diver at a time in a strong surf or current but other divers may be used to ensure a thorough search. The additional divers should swim the same sweep as the first diver.

(aa) Fasten one end of the guideline to an off-shore anchor or to an object on the opposite shoreline.

(ab) Attach the other end of the line to an object on shore.

(ac) The guideline should be played out from shore a given distance each time the diver wins out to the anchor, or to the opposite shore, and back.

(ad) If the object of the search is not found, move the two anchors to a new location and repent the search pattern.



(vi) **Search with a Weighted Line-**When a search is required around a pier or wharf which is oddly shaped, or has pilings to provide boat slips, the divers may swim from a guideline which is held by a person on the piers

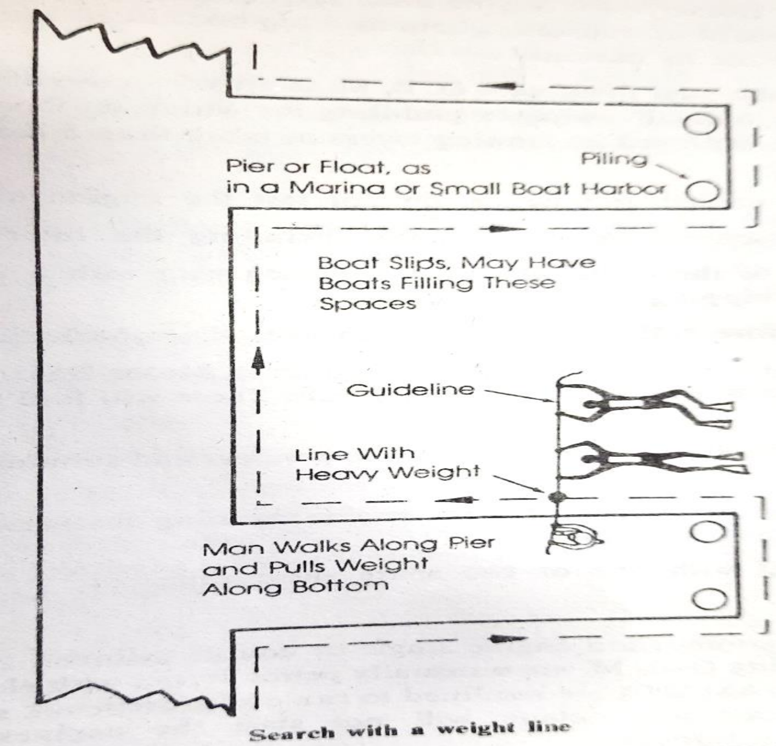
(aa) Fasten a weight near the end of a length of rope. Leave approximately 5 feet (1.5 metres) of line extending past the weight for each diver.

(ab) Lower the guideline until the weight barely touches the bottom. If the bottom is muddy, raise the weight so that it will not stir up the mud and reduce the visibility.

(ac) The divers should position themselves along the guideline and swim abreast, keeping the guideline at right angle to the pier. Sufficient divers should be used to completely sweep the area with not pass since the weight and the divers' fins will stir up in the bottom and reduce the visibility.

(ad) The person on the pier should pull the weight along the bottom slowly and guide the divers through the search area,

(ae) The divers should swim slowly so that they do not get ahead of the guideline move in a circle.



Search with a weight line

DEEP WATER RESCUE BY HELICOPTER

17. Rescue may also come in the form of a helicopter. The most popular retrieval device in use for hoisting a water survivor is a mesh screened rescue basket. The use of the basket is rather obvious; it has an open top and all that is required of the survivor is to climb in and stay as he is raised to safety. Other methods of rescue are the rescue sling (horse collar) and the rescue net. The rescue sling is a padded belt that is wrapped around the back and under the arms of the survivor. The two ends of the sling are attached by their looped rings to a hook at the end of the helicopter cable. The rescue net is a rope-like cage with an open side for the

survivor to enter and be seated while being raised to safety. No matter which approach is used, a victim be assured that rescuers will enter the water to assist a person in getting into the retrieval device if he is not able to help himself. If victim are located by a landplane that is unable to land on the water, floatation devices and rafts may be dropped so the victims can survive until other rescue operations can be carried out.

APPX

OUT BOARD MOTORS

Water Transport vessels are fitted with engine for promulsion whereas smaller crafts such as country boats, whalers, cutters etc. are designed for rowing and pedalling these small boats can be fitted with Out Board Motors for ease of operations. O.B.M. is in fact an improvisation over manual operations.

Out Board Motors are available in various ratings of Horse Power ranging from 7 HP to 100 HP smaller motors are ideal in still waters with a light fibre glass dingy. For use in heavy boats and current waters higher horse power engines are to be used.

Installation of O. 8. M. to Boat

(a) Choose the correct Horse Power for the boat. Higher Horse Power O. B. M. fitted to a small boat will break the power board or transom, where as a big boat fitted with small H. P. will not have effective thrust and may drift in current.

(b) Always remember the boat fitted with O. I. M. is only for case of operation, it does not give extra power more than the manual rowing or paddling for which the boat is actually designed. No Small Craft or Raft is to be deployed in running caters of more than 5 Knots. If the O. B. M. fails it will result in a disaster.

(c) O. B. M. is water cooled and hence, do not test the engine outside the water.
(d) Remove rudder assembly from the pintle including the tiller before fixing O. B. M.

(e) Secure the handle of the O. B. M. to the mooring ring with a rope, to avoid the engine falling over board while shipping or unshipping

(f) Start the engine before embarkation and stop after disembarkation. Idle in between trips.

(g) All safety precautions and rules of the road apply to Motor Boats, in addition avoid going through water weeds and keep a look out for fishing nets. These will foul the propeller if entangled and break shear pin.

(h) Do not go fast in unknown water routes, shallow waters and submerged rocks may capsize or damage the boat.

(i) Do not change gear liver position with engine running fast and also before coming to neutral for reverse or forward position.

(j) Carry repair tool kit with one or two spare shear pins.

Technical

O. B. M. is an internal combustion engine single or double cylinder, 2 stroke. For efficiency of easy starting and re-availability O. B. M. are unusually petrol driven with electrical sparking for ignition. Few O. B. M's such as YAMAHA are modified to run on kerosene oil, starting and switching off being petrol Kerosene, since low octane will not start the engines, such engines require petrol in the carburettor for starting.

(a) Cooling System-Out Board Motors have water cooled Engines impellors pump coolant (Water) to the outer jacket of the engine, the circulated coolant flows out through exhaust port.

(b) **Start and Run**-Starting and running is by Electrical sparking of the compressed air-fuel mixture in the cylinder Electrical Energy is obtained from the magnetic coil assembly. The starting of O. B. M. is done by cranking the engine. For cranking a rope is fitted round a spring loaded can which couples to the engine on pulling and reeves the rope on return, uncoupling from the engine on reverse rotation. Efficient engine will start with one or two sharp pulls on the starting rope.

Trouble Shooting and Common Failures of O. B. M.

Engine fails to start when

1. **Excessive fuel in the Cylinder (Rich).**

Remedy: Cut of fuel supply allow the excess fuel to evaporate for some time and crank without opening fuel supply.

2. **Lean fuel or No Fuel in the Carburettor**

Remedy: Check the fuel supply hose connections at either and for air leaks. Close the fuel taken cover for air tightness. Check free flow from the tank to the fuel adopter by pumping the fuel with thumb operator pump provided at the tank. If the fuel is flowing free than the trouble is in the carburettor assembly jet may be blocked. Clean them. Air fuel mixture ratio might have been disturbed correct it 1½ turns on the air inlet jet screw is correct setting for inflow.

3**. Less or no Electrical Spark**

Remedy: Remove the sparking plugs, clean the contacts and observe the sparks by cranking open engine. Light blue spark between the terminals is correct rating. If you do not get correct spark check the connections of the coil assembly. If the spark is weak, clean the tact points and check the condensers in the coil assembly. If the fuel and current is correct, the engine must start.

4. Engine Excessive heat and stops after run.

Cooling system faulty.

Remedy: Check the inlet port below the water line and exhaust above the water line. These may be black by mud or weeds Correct circulation with clear hot water flowing through the exhaust port with normal acceleration should not over heat the engine unless there is a sticky cylinder head.

5. **Engine starts but no thrust (Propulsion)**
Sheer pin at the propeller is parted.
Remedy: Replace the sheer pin.
Fuel supply system of O. B. M.

An air tight one gallon or Ten litre capacity tank is coupled to be engine by an air-fuel: Duel hose with suitable adopters. Part of the exhaust a gas is pumped through regulator into the fuel tank which is return pumps fuel into the carburettor fuel tank is fitted with an Air tight cap and air thumb operator pressure pump for pumping small quantity or fuel for initial starting A fuel gauze is fitted on the body of the tank to indicate fuel level.

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CHAPTER 20

RESCUE IN CASE OF EARTHQUAKES

1. **Introduction-**Earthquakes which occur in areas of human settlements will, according to their magnitude and the degree to which risk reduction methods have been successfully practised, result in casualties, death, physical or mental injuries, damage to structures and suspension of most economic activities. The problem is further aggravated due to the fact that it strikes with little warning, creates havoc in the shortest possible time and throws bewildered animals and people into panic.

CAUSES OF EARTHQUAKES

2. **Major causes of earthquake are:**

(a) The ones caused by the underground movements of the magma in volcanoes, but earth quakes caused in this way, while sometimes of local severity, never affect a wide area.

(b) The ones caused by collapse of subterranean spaces beneath extinct volcanoes.

(c) The ones caused by rock falls within the earth's crust. But these earthquakes are not felt or even recorded outside a small local area.

(d) All great earthquakes are caused by movements in the earth varying between 5 and 500 miles below the surface. Earthquakes due to this cause are called tectonic earthquakes. Thousands of cubic miles of rock strain against each other generally along a fault' on weak line, and the sudden adjustment of the immeasurable masses of the earth causes a shiver to pulse through the entire globe. The shock of the immediate area rarely lasts for more than a minute and generally only for a few seconds, but milder after shocks may continue on and off for weeks or even months,

(e) Yet another cause is that the quaking point of an earthquake is, enhanced by what are called 'trigger forces'. It generally takes years, sometimes fifty or more for the earthquake producing strains within the earth to arrive at the quaking point. At this juncture a comparatively slight additional stress suffices to upset equilibrium and touch off the earthquake. These trigger forces as they are called are of various kinds. Some are atmospheric, such as rapid changes in atmospheric pressure. The sudden accumulation or melting of masses of snow have been suggested as possible trigger forces as has also the action of tides. There is considerable evidence, although it is not conclusive that the moon on the earth may also at times be sufficient to set into action an earthquake which is all but ready to go.

CASUALTIES

3. Some of the major casualties caused by earthquake may be in the form of:

(a) Total or partial collapse of buildings.
(b) Falling debris.
(c) Earthquake induced fires.

(d) Floods from collapsed/cracked dams or river protective works.
(e) Release of hazardous substance gases.
(f) Avalanche.
(g) Land or mud slides.
(h) Tsunamis

CIVIL DEFENCE PROCEDURES

4 **General**-Earthquakes figure prominently amongst natural disasters demanding preparedness and it is essential to take strict civil defence measures to provide security for citizens and their possession against seismic risks thereby lessening the effects of the calamity and promoting normal conditions.

PROCEDURES BY GOVERNMENT

5. Civil Defence procedures can be outlined in two parts: -

(4) **Precalamity Procedures.**

(i) Establishing vital installations in areas subject to earthquakes should be abandoned Necessity of keeping away from the areas which are subject to natural catastrophes such as foods, earthquakes and tornados may be impressed upon.

(ii) Adopting special designs providing extra strength for buildings in the areas subject to medium intensity earthquakes.

(iii) Establishing centres of earthquake observation, completing intensity maps and determining the sons of surface centres accurately so that they fully comply with the contents of both paragraphs (i) and (ii) and also to make available the data necessary for the forecasting of earthquake occurrence.

(iv) Providing the executives as well as the technological facilities necessary for the study of earthquake forecasting and the use of relevant devices.

(v) Making available the vehicles and machines necessary for firefighting and first aid and training of personnel who would use them.

(vi) Making available enough hardware and stocks of materials, required for the transport and accommodation of casualties and homeless persons as well as securing them various means of living until they are suitably settled.

(vii) Pursuing research and local as well as international seminars related to the risks of earth quakes including co-ordination with neighbouring countries and international organisations in this respect.

(viii) Establishing operational organisations (civil works and civil defence) and supplying them civil defence with communication and warning systems for the affected areas, controlling works carried out as post-catastrophic actions.

(ix) Spreading awareness amongst citizens with regard to the tasks of civil defence and providing training for citizens on the civil defence works, continuously so as to achieve the tasks subsequent to the occurrence of catastrophe. Qualified persons in the affected area would help, hence their participation as much as possible in preparedness.

(x) Co-ordinated setting up of the operations of civil defence during emergency. These plans Include all the required measures to be taken by various agencies concerned with civil defence, including a plan to mobilize vehicles and technological equipment of the public sector for the purpose of using them in civil defence at the time of emergency as well as mobilization of private and public hospitals.

(b) **Post Disaster Procedures**.

(i) Warning the citizens of the affected area (preferably before hands and supplying any available data that may enable them to prepare so that all required procedures may be taken in order to minimise losses and casualties. All concerned authorities are also to be warned.

(ii) The government decides what constitutes the catastrophic. Such decisions be notified to the State/District authorities as also Director General Civil Defence, who in turn activate the Civil Defence machinery to attend to their headquarters.

(iii) Raising preparedness to the top alert level. This includes the Directorate of Civil Defence as well as the state government/district administrations and concerned installations.

(iv) Reconnaissance of the situation in the affected area and urgent estimation of the volume of losses and their nature mainly to help estimate the size of the forces and means necessary for intervention, and conducting civil defence works, including surveillance of the roads leading to the area.

(v) Deployment of the appropriate forces to undertake the civil defence works Priority would be given to life saving and providing first aid for casualties and transporting wounded persons to hospitals, as well as fire extinction and subsequent elimination of debris.

(vi) Evacuation of victims to the accommodation places, including transports, camps and buildings which are set up for this purpose besides securing the means of living and health care facilities as well as social welfare and moral raising.

(vi) Co-ordination and co-operation between various provinces particularly those adjacent to the affected area together with agencies supervising civil defence activities is that area.

(viii) However, support can be requested from friendly countries and international organisations if needed, by means of a resolution by the government.

(ix) Control of the environment and health situation in the area and taking the proper measures in due time.

(x) Repair and maintenance of cracked buildings and demolition of those likely to collapse.

MEASURES BY THE CIVIL DEFENCE ORGANISATION

6. (a) **Damage to Buildings**.

(i) **Causes**-Building damage in an earthquake more often results from structural weakest or the condition on the ground underneath rather than from the strength of shock waves Damage often results because horizontal pressures are exerted against designs that were intended to contend only with vertical stresses Also there may be uneven resistance in different parts of a structure. As a result, the regid parts may be broken or torn loose. A brick chimney for example that cannot move with the flexibility of the remainder of the structure will often break off. There are five elements in an earthquake that cause damage to manmade structures.

(aa) Strength of waves.
(ab) Length of motion.
(ac) Proximity to the fault.
(ad) Geological foundation.
(ae) Building design.

(ii) **Wood frame Buildings**- Well constructed wood frame buildings are highly quake resistant because the frame, roof, exterior wall and ceiling panels supply the necessary bracing. However, because fire is often a result of an earthquake, wood structures may be damaged or destroyed by this hazard. Regular masonry structures have a tendency to be vulnerable to damage because of their heavy mass Heavy tile roofs are a hazard because the shaking motion may send the tiles crashing to the ground.

(iii) **Concrete Buildings**-When good brick of concrete block has been laid with strong mortar well reinforced with steel and properly bonded to foundations and inner walls, this type of buildings will give good resistance to earthquake shock. If a concrete slab floor is of good quality, the footings are secure and the soil beneath is firm: then it should not be an earth quake problem.

(iv) **High Rise Structures**-The slow and gentle rocking motion of a quake may affect tall buildings even when they are 100 to 200 miles away from a major earthquake. The gentle oscillation of the earth's surface can cause a condition called "Quasi Resonance" which may have an effect on buildings which are five or more storeys high. A building will usually be able to withstand earthquake shock if it is balanced and well tied together. A structure must be so designed that it will move with the earthquake as a unit rather than an unrelated assemblage of parts. It must also have strength. This can be achieved by effective bracing and by securely anchoring and bending all elements such as the foundation, frame, outer and inner walls, upper floors and roofs. Good quality material and workmanship are also essential.

(b) **Functioning of Civil Defence Organisation-**From the list of causes given in para (i) above, it is clear that fire, flood, release of hazardous substances, avalanche and tsunamis can all be prepared for as separate events and separate from earthquake One or more of these events will almost certainly follow the earthquake and make most difficult the task of dealing with casualties. Quite apart from the possibility of structure damage to hospitals themselves the collapse of buildings and bridges can communication failures (certainly telephones and possible radio and/or television. If the studios or transmitters are affected or if people rely on mains power for reception). All these will require adaptable and flexible counter measures.

(i) **Rescue**-In large earthquakes it is not uncommon to find that injuries exceed deaths by a ratio of 3:1. Whatever the absolute numbers may be, this certainly argues that major effort should be devoted to hospital preparedness, casualty management and the training of rescue and first-aid teams. These may be drawn from Civil Defence permanent or volunteer personnel, the Red Cross, or organisations like the Scouts, which have no primary medical or other emergency affiliation. Some aspects of their training in relation to the disabled and to those whose injuries might result in disablement, need to be given special emphasis. In searching for and discovering the injured who may be buried under debris, much valuable assistance has been rendered by specially trained dog teams, although there are some dis advantages too, stemming from the need to rest the dogs after a few hours work. Sound equipment, which can pick up very faint noises made by people trapped and buried, does not have that problem but, on the other hand, its use often demands silence in the area being searched, and this is not a requirement which is readily met in such circumstances.

(ii) **Fires**-Fires after earthquakes can often spread very rapidly, not only because of the potentially large number of ignition sources such as ruptures in gas mains or broken and fallen power lines, but also because water mains may no longer be functioning. A particular problem is posed by fire in high-rise buildings, whose lifts may be out of action because of damage or power failure. Fire rescue vehicles will not have ladders long enough to reach upper floors where people may be trapped. Moreover blocked streets may present access by fire-fighting vehicles. If at all practicable, planning should envisage the calling-in of Heli copters to assist in rescues from high-rise buildings, and the regular inspection of fire prevention measures and mechanical escape equipment by officers of the fire service.

(iii) **Collapse of Dam/River Embankment**- If a dam or a river embankment collapses at the time of the earthquake there may, particularly where a dam at the head of a valley is concerned, be a sudden and catastrophic release of water and no amount of preparedness planning will avoid a heavy loss of life. Similarly, where a river is confined between raised earthworks and flows at a level higher than that of the land on either side, rapid inundation of a flood plain will inevitably follow a major breach of those retaining works. Widespread property and agricultural damage is certain to ensue, the extent of human casualties will depend upon the local situation, the time of the event, and whether there has been an opportunity to issue any form of warning. There may however be cases where a dam is known or suspected to have been weakened by an earthquake, or where signs of failure seepage, for example, are detected in river protective works. The presence of dams or river embankments will of itself have caused the preparation of plans to deal with flooding and flood fighting because dams may collapse for reasons other than earthquake-and embankments may be overtopped or breached during any flood season. There will then be time to put these plans into effect.

(iv) **Avalanche/Landslides**-Very much the same principles apply for avalanches and landslides. If these are major events, triggered immediately by the earthquake, then planning will be of no avail. A classic example was the obliteration of the towns of Yungay and Ranrahirca in Peru in 1970. Here a section of Mount Huascaran fell away in a debris avalanche consisting of 50 million cubic metres of rock, snow, ice and soil. This mass travelled some 15 kilo metres, at an estimated speed of up to 320 kilometres per hour, surmounting obstacles over 140 metres high. Some 18.000 people were killed in the two towns, 92 are known to have survived. Preparedness would not have avoided this tragedy, although long-term disaster prevention might have done so in 1962 an avalanche of some 13 million cubic metres fell from Mount Huascaran and killed nearly 4,000 people in Ranrahirca and nearby villages. Total evacuation as a prevention measure might have followed that event, as the actual hazard (accumulation of ice on the mountain) had not been removed, or even reduced to any marked degree. Less drastic prevention measures such as the removal of material from the head of a slope, or adding material at its foot in order to stabilize it, can be adopted if measurements show that any motion is taking place which might precipitate a landslide. Snow avalanches can be deliberately induced to prevent a larger and potentially disastrous event latter. Extricating trapped victims from collapsed residences during a massive landslide is hazardous, because the structure is usually very unstable while it is still in motion. Even though the rescued residents may vehemently assert that all occupants have escaped, the structures still must be systematically searched for trapped or injured intruders or forgotten visitors. If the structure is somewhat stabilised a thorough room-by-room search must be started and kept up until all sections have been checked. If the building is unstable and further slippage is a distinct possibility, then it is necessary to calculate whether the possibility that a person may be in the structure will warrant jeopardising the lives of rescue personnel.

(c) **Public Utility Services**-Apart from the question of dealing with casualties, proper planning measures will have to be taken to deal with other primary effects of an earthquake, especially where these cause interruptions to "lifeline" public services. These primary effects include:

(i) **Blockage or Breakage of Transport Activities**-Heavy (earth-moving) equipment will be needed to clear debris from roads, and may also be required for cutting temporary bypasses round large landslides so that emergency traffic at least can get through. Similarly, it may be possible to create temporary access roads and a shallow ford across a river if an important bridge has been broken. The need for this kind of emergency engineering will be dictated by the number of alternative routes (including railways) which remain available. Prior arrangements for the provision of heavy equipment will require co-operation from the government's Public Works Department as well as, possibly, from private contractions. If large-scale construction projects are under way in or near the affected area, it may be possible to obtain additional ad hoc assistance with machinery and drivers from those locations, this is not necessarily something which can be planned for, but the potential should not be overlooked.

(ii) **Interruption of Water Supply**-Although the greatest share of responsibility for rapid restoration of the public water supply rests with the local water Authority, the emergency planner must try to ensure that:-

(aa) **Earthquake**-proof emergency water storage tanks are constructed in areas where the risk of fire following earthquake is greatest\.

(ab) Liaison arrangements exist between the authorities responsible for water supply and those whose duty it is to deal with sewage disposal threats to public health could ensue if sewers were damaged even though water delivery systems themselves remained operable.

(ac) In areas where there is a high probability of earthquake, households and institutions retain a stock of canned or bottled water for drinking and that a central stock is also held, particularly for the benefit of the elderly and disabled.

(ad) Tanker trucks can be obtained to enable street deliveries to be made.

(ae) Full use is made of water which may be stored in swimming pools and private reservoirs

(iii) **Breakdown of Sewage Disposal Systems**-The health risks from broken sewer lines will be compounded if the sewers become blocked and/or water-flushed lavatories cannot be used. It may be necessary to plan for the installation of public chemical toilets in cities, as well as in places or areas (public buildings or tented camps) to which people are moved. There are also available solvents or chemical coagulants which can be used to render faecal material harmless from a health point of view, and capable of being stored until conditions permit of its disposal. The Japanese "Sawayaka jelly", invented by the Director of Disaster Prevention In the city of Yokohama, is an example of the kind of coagulant which can be used.

(iv) **Electric Power- Telephones and Gas Services**-Detailed planning for the restoration of services will inevitably be in the hands of the specialized authority and it will normally also be responsible for providing temporary emergency services for priority users. The emergency planner will need to be aware of the extent to which the resources of the authority is likely to be adequate to deal with the effects of major earthquake, so that he will know whether he must be ready to arrange for those resources to be augmented from the military, or even from outside the country. Breakages of power and gas transmission lines can pose a threat of a secondary emergency (explosion or fire) as well as to the lives of individuals through electrocution or asphyxiation and it may be necessary to issue warnings to the public where such breakages are known to have occurred.

(d) **Shelters**-The provision of emergency shelter after an earthquake will generally be a major pre-occupation of relief operations managers. Preparedness planning can assist here, especially, if appropriately qualified civil engineers and architects can be enlisted to make, in seismic areas:

(i) A study of the historical vulnerability of different types of construction.

(ii) A study of the prevailing quality of building materials (it should be remembered, however, that most houses fail not because of the quality of materials, but because of the way in which they are used),

(iii) An examination of the quality of the workmanship typically used in building houses (the performances of many structures could be enhanced by simple. improved masonry or carpentry techniques).

(iv) A note of those features of traditional houses making them particularly vulnerable to prevailing hazards e.g. a symmetrical form in plan, section and elevation which increase vulnerability to earthquakes.

(v) An examination of the suitability of a house to its environment (building techniques and building types follow population migration, often into areas for which they are climatically and physically unsuited, thus increasing their vulnerability to natural hazards; and

(vi) An analysis of the site, especially its location and soil conditions in relation to prevailing hazards (unstable slopes, loose unconsolidated soils, flood plains, etc. should in principle be avoided in housing reconstruction programmes).

PRECAUTIONS AND SAFETY RULES IN CASE OF EARTHQUAKES

7. **Precautions by Public**-There is little danger in open country from the results of a quake, if there is no falling debris in the area. It is probably safer to stay inside a modern building which has been constricted to resist earthquakes damage. Frightened people tend to rush outside during an earthquake, and this probably is the worst thing they can do because they are vulnerable to collapsing walls as well as falling masonry and glass. Inside a building, debris and fixtures will be falling and glass panes breaking. Individuals should follow the undermentioned simple precautions:

(a) Switch off the lights and power supply.

(b) Move away from glassed windows and doors.

(c) Stand behind an inside doorway.

(d) Crouch under a desk, table or bench.

(e) Do not stay inside buildings with a large roof span unsupported by walls.

(f) Put off all stoves and gas ovens.

8. Individuals who are outside should move away from the possible range of falling debris, chimneys and overhead water tower/tanks. If they cannot move away from buildings they in to the doorways where they can take advantage of overhead protection.

9. **Safety Rules**-The following points should be looked into in order to minimise damage to life should get and property due to an earthquake in earthquake prone areas.

(a) **Before Earthquake**

(i) Check for earthquake hazards. Bolt down or provide other strong support to gas and power appliances. As much fire damage has resulted from toppled appliances and broken gas lines.
(ii) Place large and heavy objects on ground/lower shelves of storage almirahs etc.
(ii) Do not stack glass or crystal ware as slight shaking will topple it.
(iv) Overhead lighting fixtures should be properly anchored.
(v) While constructing new buildings, follow buildings modes and other sound practice to eliminate earthquake hazards. Build on solid ground or dig down to bed rock when laying foundations. Avoid filled and sediment areas as much as possible.
(vi) Know your local ER/CD set-up.

(b) **During an Earthquake**

(i) Remain calm, think through the consequences of any action you plan to take, try to calm and reassure others.

(ii) If indoors watch for falling plaster bricks/stones, light fixtures and other objects

(iii). Watch for high book cases, shelves and other cabinets which might slide or topple.

(iv) Stay away from glass windows, mirrors and chimneys.

(v) If in danger get under a table, desk or bed in a comer away from the window.

(vi) Encourage others to follow your example and do not run outside.

(vii) If outside avoid high building walls, power poles and other objects that could fall. Do not run through streets. If surrounded by buildings take shelter in the nearest strong one.

(viii) If possible move to an open area away from hazards.

(ix) If in an automobile, stop in a safe place available, preferably an open area.

(c) **After an Earthquake**

(i) Check for injuries, do not attempt to move seriously injured persons unless they are in immediate danger of further injury.

(ii) Check for fires.

(iii) Wear shoes in all areas near debris and broken glass.

(iv) Check utility lines and appliances for damage. Do not use matches or lighters und it has been established that there are no gas leaks.

(v) Check and see that sewage lines are intact before using/flushing of toilets.

(vi) Draw moderate quantity of water in case service is disrupted. Do not draw large quantity as this would interfere with fire-fighting.

(vii) Do not eat/drink anything from open containers, especially near shattered glass

(viii) Do not turn light switches on and off. This creates sparks which may ignite from broken lines.

(ix) Do not spread rumours, they often do great harm following disasters.

(x) Respond to requests for help from civil defence, fire services, police and home guards.

(xi) Do not crowd into damaged areas unless help has been requested. Co-operate with the Public Safety Officials.

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CHAPTER 21

RESCUE BY HELICOPTER

1. **Introduction**- The use of helicopters by the various emergency services is rapidly growing Casualty evacuation, the transportation of medical and rescue teams being just some examples. However, before the decision to use helicopter is taken a number of factors need to be considered: -

(a) **The time of flight up to the site of incident**-The time involved in flying to the incident may well be better used to transport that patient by normal means. Advice of the estimated flying time can be obtained when the original request for the helicopter is made.

(b) **Location of Casualty**-Use of helicopter may be justified in case the location of the incident is such that recovery by normal methods may endanger or aggravate the patient's condition.

(c) **Condition of the Patient**-The patient's condition in relation to the weather conditions.

2. The most significant role played by helicopters in rescue operations is that of providing immediate assistance to survivors and serving as eyes of approaching rescue units. Orbiting the survivors, dropping survival equipment and confirming the position all serve to improve the morale of the survivors provide for their immediate emergency needs, fix the location to prevent additional long searching and save valuable time in getting a rescue unit on the scene.

OPERATING PROCEDURE

3. **General**-All rescue personnel must remain constantly aware that many persons have been killed and injured while boarding or working around helicopters. Rescue crews assigned to ground duty and passengers should know the rules for flight safety, procedures for loading and stowing equipment, and ground safety rules. These practices, coupled with mature judgement and alertness will result in safe and effective air operations.

4. **Request for Helicopter**-The call out co-ordination and request for helicopter rescue will be made to the control room established at State level through the Sub-Control/Control Centres either through telephony or by radio. The request for helicopter rescue should include the following information:

(a) The location of the incident or chosen landing site, using a grid reference, or a description of the site.

(b) A brief account of the incident together with the type and number of casualties

(c) A location of the hospital that is best suited to treat the patient's condition e.g., it may be better to transport the patient to a specialist hospital unit by passing the local hospitals. However, the extra flying time together with the patient's condition will be a determining factor.

(d) Details of weather at the incident, i. e. an estimate of the wind velocity, cloud base and visibility (this is not essential and may be omitted if it would cause delay as the crew has access to national Meteorological facilities).

5. **Landing Site**- The helicopter has limitations Rescue personnel must always remember that the pilot best knows the ability and limitation of the aircraft. The pilot is in charge of and responsible for the safety of the aircraft and all the pilot's decisions are final and must be obeyed. Rescue personnel who may be involved in helicopter operations must be aware of what conditions combine to make a good landing site. If the entire crew is knowledgeable the pilot's job will be made easier and the entire rescue operations can be completed effectively, efficiently and safely. When a helicopter arrives on the scene, invariably the first item of business is to reconnoitre the area and evaluate the landing site. There are several considerations in selecting a suitable landing site. These include, but are not limited to wind, obstacle clearance, surface lighting if at night, security and communication. Improvised landings sites must be clear of obstacles i.e., trees, telephone cables and pylons etc. In addition, an area approximately half the size of football pitch will be a clear approach. The ground should ideally be level or of no more than an approximate 10 percent slope and need to be of firm standing. It should be clear of all loose articles and objects that may become a hazard upon arrival of the aircraft. Plastic bags can provide a major hazard if blown up into the helicopter rotors. Do not use an “H” pegged to the ground as the power from the rotor downwash will dislodge the pegs and the material then becomes hazardous. Radio contact with the aircraft can be made using a standard call sing of “Rescue Helicopter”. This code sign should be known to the rescue team/Incident Control Officer at the site of incident. Should the service helicopter be requisitioned the same may not be required.

6. **Arrival of Helicopter-**The helicopter crew would navigate toward the given grid reference but assistance can be provided by the use of smoke flares or blue flashing beacons. If these are available then they should be deployed when the aircraft is first seen/spotted. Avoid firing flames directly at or in front of the aircraft for obvious reasons. At night a blue beacon is visible for some distance and this is often sufficient the pilot will use vehicle lights to judge his approach and height and this point should be borne in mind on such operations. Most search and rescue helicopters have sufficient landing lighting to enable them to land without assistance and the provision of ground vehicles using headlamps is unlikely to be required.

7. **Landing**-Probably the first thing that a pilot does is to determine the direction from which the wind is blowing. This is done by windsocks, smoke trees, wind streaks on the water etc. The direction of the wind and obstacle clearance are the two most important factors when making an approach into and landing in an area other than an established airport or heliport. Ideally, the pilot like to land directly into the wind. A tail wind or cross-wind affects both the performance and the manoeuvrability of the aircraft. Having evaluated the wind conditions, the attention of the pilot is directed to the obstacles that surround the proposed landing site. Pilots are reluctant to make approaches into areas where tall trees, power lines, or buildings lie in the flight path. The inherent danger is obvious. Not only is there an increased risk of striking an object but should a power loss occur the pilot has no choice but to attempt a landing into the barriers. The approach then, if possible, should be over a clear area and into the wind. Very few cases arise though where the approach is directly into the wind and over a perfectly clear area. However, the pilot selects an approach that provides the best combination of these two variables. Generally, the more open the proposed landing site is the more suitable it becomes. Another item of significant importance is the general condition of the landing surface. Clear

level pavement or other hard surface is preferable. An accumulation of debris in the immediate vicinity presents a hazard in that rotor wash can propel loose objects into the engine intake. Engine failure is the obvious result. While helicopters certainly can land on send it is undesirable. Sand blown by rotor wash can at times reduce the pilot's visibility and it accelerates engine wear. Wetting down the landing site will reduce the problems caused by blown sand and dirt. If the evacuation occurs during hours of darkness lighting can be important. Well-lit areas improve the pilot's depth of perception but personnel should guard against improper or careless use of lights Make sure no floodlights are pointed upwards into the approach path. Also take care not to shine lights directly into the cockpit as this can blind a pilot. A useful suggestion might be to form a large square with cars and turn the headlights on. This lights the landing area quite well. Upon touchdown of the aircraft DO NOT APPROACH until signalled to do so, indicated by a "thumbs up" sign or at night a flash light. Always approach the aircraft from the starboard front quarter so as to be within the crew's angle of vision and NEVER approach the aircraft from behind due to the dangers associated with the tail rotor. In addition, the "Wessex" type of helicopter presents an additional hazard of approach presented by the hot exhausts (300 degrees centigrade).

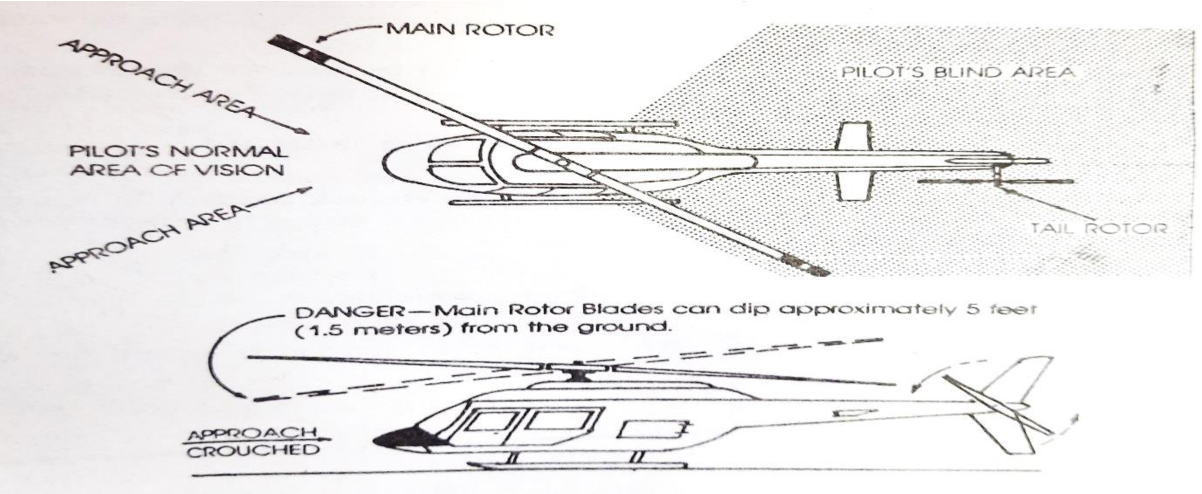
8. **Emplaning and Deplaning**

(a) Approach the aircraft when signalled to do so and go directly to the cabin door, keeping all loose objects such as maps etc. secure. When close follow directions from the aircrew about where to step. stow equipment and sit. always approach or leave a helicopter form the front or downhill side within the view of the pilot. Walk in a slightly stooped over head down position. Remember that the slower the rotor is moving the lower it will dip. Never approach from the rear because there is danger from the tail rotor. During take offs and landings all personnel should remain well away from the aircraft. The main rotors may dip to one side as the crafts moves and the tail rotor may swing around. Do not approach the helicopter until a signal is received from the pilot or crew member. Passengers should not enter or leave the helicopter without the pilot’s permission. Personnel must not approach the craft until the engine is off and the rotors stopped or the pilot signals permission. Even after touchdown the pilot may want to shift the helicopter’s position.

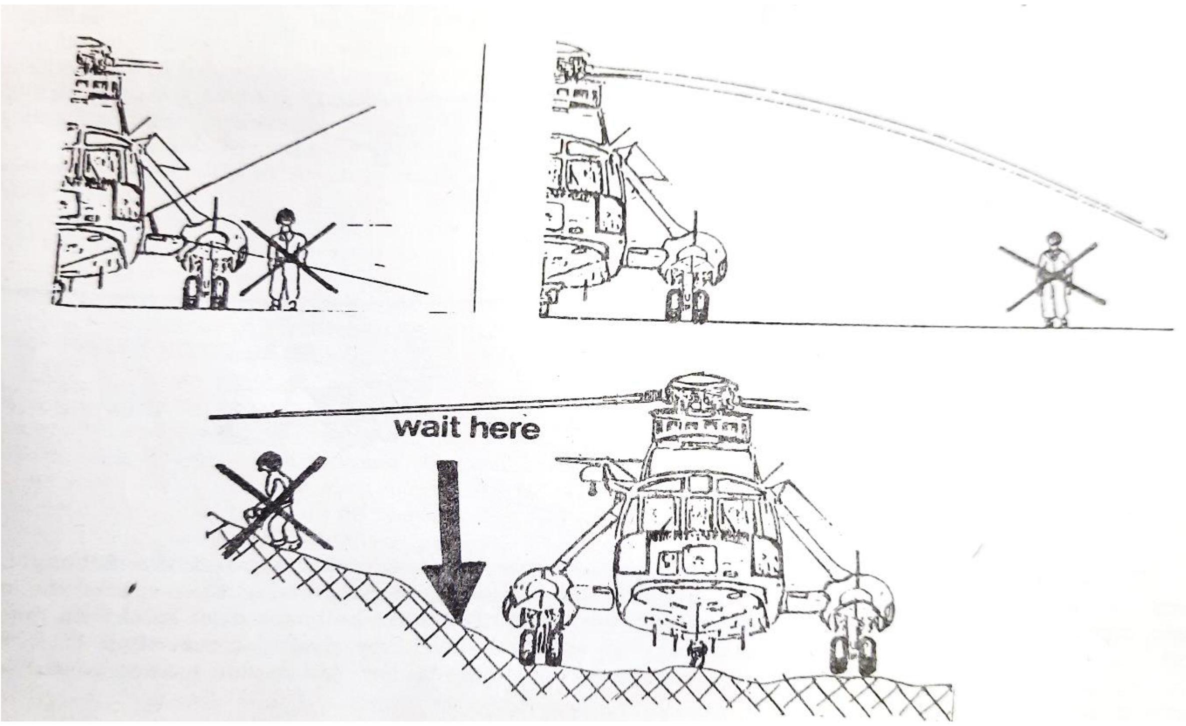
(b) It is advisable to switch off any radio equipment when boarding the aircraft, ground communication being best obtained through the aircrafts own systems which utilise both VHF and UHF multiband radios.

(c) When leaving the aircraft take advice from the aircrew where to wait or stand.

(d) It may be that to avoid the rotors you will be advised to wait close to the helicopter, due to ground slope, until the aircraft has lifted away.



The vertical rotors will "sail" when the aircraft is started up or closed down and care should be taken during the operation. In most operations the rescue helicopters will leave the rotors still running, therefore not presenting a hazard although advice from the aircrew must be followed without question. Apart from this the following should be strictly observed:



(i) Obey the winchman's instructions.

(ii) Carry long equipment horizontally. Tools, skis, litters and similar items should be carried low and parallel to the ground when approaching or leaving the aircraft so that the rotor blades will not be struck.

(iii) Secure loose items, especially headgear. Personnel in the crew should wear hard hats with chin straps fastened, goggles, and bright jackets or vests. Soft hats and caps must be held by hand.

(iv) Remain strapped in, if appropriate, until otherwise instructed.

(v) Lower your head in the rotor area.

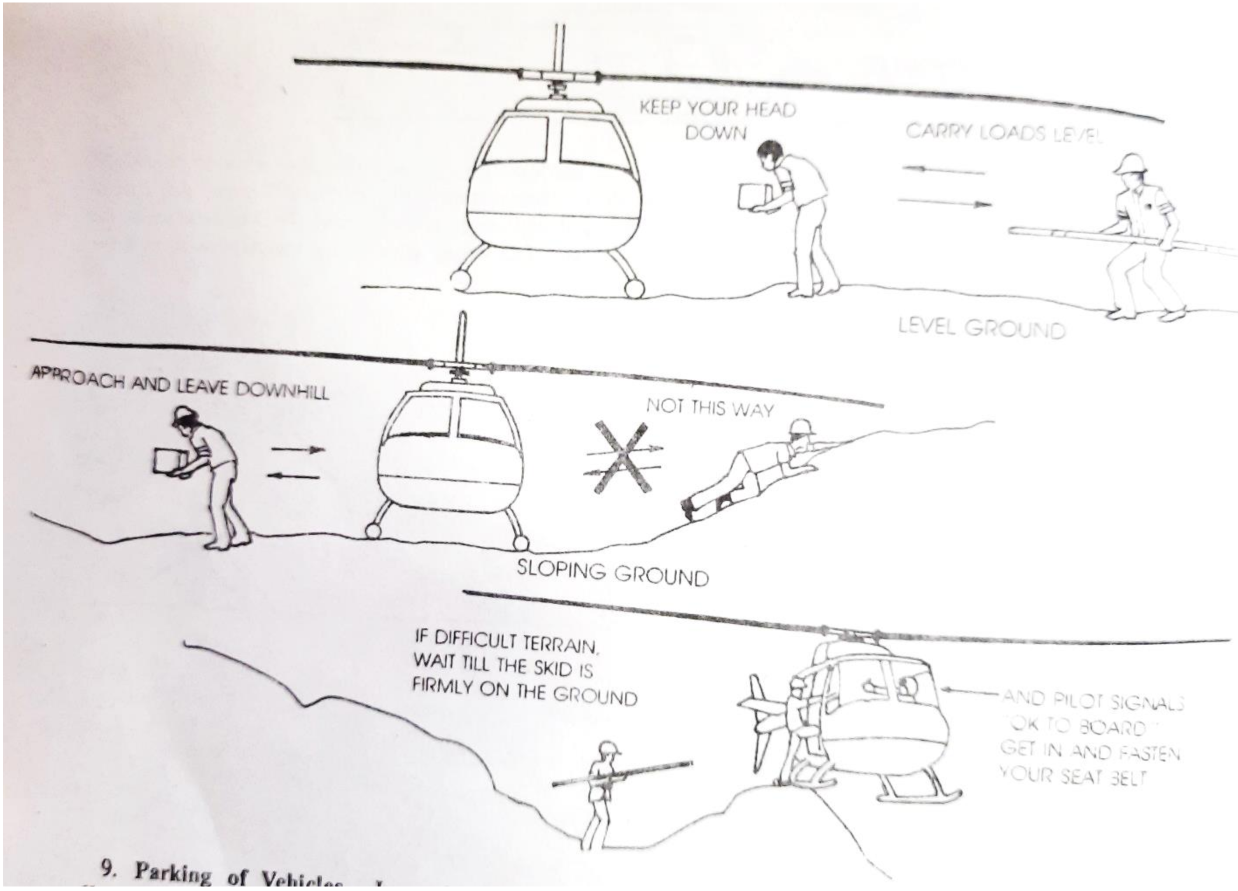
(vi) Kneel in line with equipment secured at the two O'clock position 30 meters from the aircraft. Do not approach aircraft or enter the rotor disc area without permission by signal ie. "thumbs up" etc. from the aircrew.

(vii) Smoke within 50 metres of aircraft.

(viii) Enter or leave the rotor disc area without permission.

(ix) Throw equipment especially sharp or heavy items on board.

(x) Touch handles identified by yellow and black markings except for emergency egress.



9. **Parking of Vehicles-**In order to allow people room to work around the helicopter as well as for safety reasons, it is advisable that all vehicles remain outside the area of the rotor disc. Ambulances should be driven parallel to the helicopter with their rear door level with the rear left-hand passenger door of the helicopter. No vehicles should be parked closer than 15 ft. from the helicopter and reversing should not be done towards the helicopter except under strict guidance.

RESCUE TECHNIQUES

10. Air Ambulance Operations-When a helicopter is being used as an air ambulance, a number of patient care and evacuation procedures should be considered that may differ from the usual methods. Helicopters in emergency medical services are intended to:-

(a) Provide quick identification and response to accidents.

(b) Sustain and prolong life through proper emergency medical care measures, both at the scene and in transit.

(c) Provide the coordination, transportation and communications necessary to bring the injured and definitive medical care together in the shortest practicable time, without simultaneously creating additional hazards.

11. Travelling by helicopter imposes a certain degree of roughness and vibration on the passengers. When comparing this to the roughness and vibrations encountered when riding in ground ambulances, it is necessary to consider other factors such as smoothness and contours of the roadway, Relative to the ground ambulance, experience has shown that the helicopter is less detrimental on rural or remote missions and more harmful on metropolitan trips. Any rough movement, vibrations, or sudden jerks of a patient cannot help but bring further discomfort and could add to the severity of the victim's condition. If at all possible, intubation of the airway must be performed and intravenous (IV) administration of fluids should be started before taking off, because once airborne these operations are complicated by the vibration and turbulence of flight.

12. Some types of illness and injuries are adversely affected by the decreased atmospheric pressure encountered as an aircraft gains altitude. Because helicopters normally cruise at lower altitudes then fixed-wing aircraft, the medical problems pertaining to altitude are normally not as serious. At altitudes under 1,000 feet (300 meters) the considerations pertaining to oxygen administration are the same and difficulties encountered in case of vomiting, sucking wounds, of the chest, and injuries to the sinuses, cars, and brain are dealt with in the same manner as during ground ambulance transportation. A victim with a penetrating chest wound and a tension pneumothorax (air trapped between the lungs and the chest wall should be transported by a ground vehicle if at all possible). The victim may be barely able to breathe sufficient air of breath sufficient air at ground level for survival because the lung capacity has been considerably reduced by the pocket of air within the chest wall. The entrapped air may cause serious complications to the casualty by expanding as the altitude increases and the atmospheric pressure is correspondingly decreased. Similar problems may occur when patients have gas trapped in their abdominal cavities by an intestinal obstruction, hernia or similar trauma. Air trapped in other body cavities, such as the sinuses and the inner ear, will likewise be adversely affected by decreased atmospheric pressures. Persons suffering

from severe blood loss, heart disease, anaemia or any other injury or disease that affects the respiratory or circulatory systems must be closely watched while being transported in an unpressurised aircraft. With increasing altitude, the air is thinner and oxygen becomes more scarce. At 5,000 feet (1,500 met res) the lungs are supplied with approximately 80 percent of the volume that is available at sea level, this concentration decreases to about 60 percent at about 10,000 feet (3,000 meters). Therefore, persons who have respiratory or circulatory problems on the ground will experience additional complications as the altitude increases. When the victims must be transported by aircraft, the pilot should be instructed to fly as close to the ground as possible. If the patient shows of increasing pain, additional difficulty in breathing or intensified confusion and mental deterioration, a lower altitude is necessary. Administering oxygen may offer some relief. The noise and vibrations of air travel interfere with communication and the evaluation of vital signs. Excessive dust in the air from prop wash or rotor wash requires that extra care be devoted to covering open wounds and securing the bandages. Cabin temperatures decrease as the flight altitude is increased. Normally, cabin heaters are adequate to compensate for this, but periodic assessment of the patient thermal comfort should be made and blankets or additional covering provided as required. Patients who have had fractured limbs immobilized with pneumatic pressure splints must be watched closely because pressure changed associated with altitude will affect the splint's rigidity. These devices have a tendency to expand and tighten at the higher altitudes and loosed at the lower levels. Additional precautions must be taken during cold weather to ensure against frostbite because of the reduced circulation caused by the air splint. The potential for airsickness and subsequent vomiting is enhanced by the presence of injury, illness or apprehension Observe the patient closely for the development of this complication, especially if the person is unconscious. Be prepared at all times to restore an adequate airway by the removal of vomit or other fluids. If the patient is to be transported on an externally mounted litter or if a hoist is to be used, before the arrival of the helicopter the victim should be informed of the method of the pending evacuation. The patient must be made aware of the noise, wind, and turbulence factors that may be expected. A patient in an outside litter must be well secured and the person's hands completely restrained to prevent any of the limbs from reaching outside the confines of the litter. Face and eye protection will prevent further injury from blowing debris caused by rotor winds. The victim is loaded with the head forward so observation of the person by paramedics is possible at all times.

13**. Search and Rescue Operations**-The helicopter is one of the most efficient SAR vehicles in use. Its slow speed and ability to hover make it suitable for search as well as rescue operations, particularly where small targets are sought or close scrutiny of the terrain or ocean surface is required. Its ability to land in a confined area and to operate from ships enables it to remove persons from inaccessible areas and rough seas, or to rescue and administer emergency medical care long before a land vehicle or marine craft could do so. Many SAR helicopters are equipped with a hoisting winch and cable for accomplishing a rescue from a hovering position. Non-SAR craft usually are not equipped with this type of hoisting capability and must perform a rescue either by landing or by hovering just off the surface of the terrain and permitting the victims or survivors to be brought aboard.

14. Winching is a relatively slow process in relation to landing and uses a lot of fuel. Therefore, is better if a landing can be made and it may be beneficial to move the patient a short distance to a more suitable site. However, if winching is required then rescue teams should be aware of the stronger downwash from the rotors when the helicopter is overhead during this operation. Once down, the winchman will give instructions how to operate the

"strop" or stretcher basket. 15. Some of the techniques employed for helicopter rescue other than ground landing are:-

(a) **Rescue Basket**-A rescue basket of which there are several models, is the preferable method of hoisting any victim with a winch and cabin, especially if the person is unconscious or can offer little or no help.

(b) **Stokes Stretcher**-The Stokes stretcher is generally used only when the condition of the victim is such that the person must be in a prone position. When either a rescue basket or a Stokes stretcher is employed, a light steadying line should be utilized to guide the device and prevent it from spinning or winging.

(c) **Rescue Sling**-The rescue sling or horse collar, may be used at any time when, in the opinion of the pilot, the use of the basket is inadvisable and the employment of the litter is unnecessary.

The use of the sling may be difficult if the victim is not assisted by a trained ground crew. The excitement of a sling hoist may increase shock or heart problems. In cases of chest, arm, or shoulder injuries, further damage may be done. The victim may slip out of the sling if all precautions are not observed.

(d) **Penetrator**-The penetrator hoist is a bullet-shaped device that penetrates the tree canopy when lowered. When unfolded, it resembles an anchor with three prongs, each prong providing a seat for one person. When sitting on the seats facing the centre or hub, a safety straps is used to secure each passenger to the penetrator. The penetrator hoist is an excellent method for landing rescue personnel or the removal of ambulatory victims from inaccessible locations.

(e) **Roof Landing** – If there is no established heliport on the roof of the building or if the craft is heavier than the roof can support, the helicopter may have to hover slightly above the deck.

These aircrafts are very heavy and can-do enormous damage to a roof that is not structurally designed for them. Capable pilots can hover a very short distance above a road and accomplish all objectives without the risks of landing. Where occupants must be evacuated from the upper floors of a tall building, there may be advantages to airlifting them off the road. Time may be saved by transporting the people to an adjacent structure, instead of to the ground. When aerial evacuation is necessary, sufficient personnel should be assigned to the roof to control the people and to maintain communication with the pilot. Personnel aiding in roof top operations must be aware that hot gases venting from roof openings could pose a problem to the pilot because they may deprive the helicopter of needed lift.

TRANSPORTATION OF RESCUE PARTIES AND EQUIPMENT

16. Helicopter can transport personnel and equipment to the roofs of buildings in which the elevators are unsafe or not operational, or access to the fire floors may be excessively delayed. When rescuers are conveyed to a roof all members should be fully equipped with breathing apparatus and forcible entry tools.

17. In case of fire situation in high rise buildings, helicopters can air lift portable tanks of water and pumps to the roof tops for a rapid attack on fire. Similarly hose lines can also be air lifted to the mol tops.

18. **Conclusion**-Helicopters are a valuable method of transport that combine speed with access to difficult locations. However, their use should be accompanied with a respect for the problems associated with them and some general principles of safety should be followed.

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CHAPTER 22

RESCUE FROM CRASHED AIRCRAFTS

1. **Introduction**-The introduction of high-speed jet aircrafts has increased the risk of accidents both to aircrew and rescue personnel. The approach to an aircraft crash presents more hazards and hidden dangers than almost any other type of accident. It is therefore of paramount importance that the Civil Defence personnel are not only aware of the risks involved in such rescue operations but also are aware of the topography of the area to reach the spot of crash within the minimum time on receipt of the information.

2 All Civil Defence personnel must be familiar with the markings on any aircraft. The emblem depicting the country would be displayed on each side of the fuselage and on upper/lower surface of the wings. The emblem indicates to the rescuer whether the aircraft is a service one or one belonging to Civil Aviation. Civil airliners invariably display company crest, name, trade letters or the country of its origin.

REPORTING OF CRASH

3. Any aircraft crash off the air field needs to be reported by the fastest means to Civil Police, Fire Brigade, Home Guards and Ambulances and Rescue Services Similarly nearest air force or civil airport authorities too must be informed for prompt assistance. The report must contain maximum information of the crash to include:-

(a) Type of aircraft-Service or Civil.

(b) Type of damage-Total or partial.

(c) Under fire or not.

(d) Location of crash and approach to site.

(e) Damage to public services/property due to crash.

MODUS OPERANDI OF RESCUE OPERATIONS

4. **Approach to the Crash Site**-The following aspects may be kept in mind during approach to the crash site:

(a) Avoid taking short cuts through fields as vehicles may get bogged down. Remain on hard surface.

(b) Do not block road or approach to site by careless parking of vehicles. All defective vehicles should be parked off the road. Average fire appliance requires nine feet clear space to get through at speed.

(c) Look out for survivors who may have been thrown clear of the aircraft and may be crawling to safety.

(d) Keep all headlights, side lights and search lights on during darkness or bad visibility for locating injured personnel.

(e) Interrogate a coherent survivor to gain information regarding number of persons to be accounted, weapon systems carried by the aircraft and whether the warning of the expected crash was given by the captain of the aircraft.

(f) All personnel and vehicles must approach the crash from an "upwind" and uphill position. Keep wind on your back.

(g) All aircraft on crash may not catch fire but definitely develop fractures in fuel tanks thereby releasing large quantities of fuel. Gasoline spirit vapour will flow down wind and free fuel will run downhill. This fuel/vapour ignites with slightest spark and may result in major fire. Most common means of ignition are:

(i) Cigar ate butts thrown carelessly during approach.

(ii) Hot carbon sparks ejected by vehicles.

(iii) Sparks caused by boot studs.

5. **Action on Arrival**-The Officer or Leader incharge of the first service arriving at the site of crash would be the overall incharge of the rescue operation until relieved by the incident control officer. Some of the major duties of the OIC would involve:

(a) **Parking of Vehicles**.

(i) Ensure all vehicles parked up hill and upwind of the aircraft.

(ii) In case of explosion and/or fire all vehicles to be parked facing outward for speedy getaway.

(iii) Road is clear for other services to function.

(b) **Policing Duties.**

(i) Onlookers should be kept as far back as possible.

(ii) No smoking must be strictly enforced in the vicinity of the crash.

(iii) Souvenirs collection to be prevented as the stolen part may be of value for determining the cause of crash.

(iv) Should the crash take place in vicinity of the built up area, all inhabitants be advised regarding :

(aa) Presence of fuel and fuel vapour.

(ab) Shut all doors/windows and removal of curtains that could spread fire.

(ac) Turn off gas and electricity mains.

(ad) Extinguish all oil lamps, candles or naked lights.

(ae) Damp down any coal fire or stoves.

(af) No one to strike match box or electronic lighters.

(c) **Fire Prevention**-If free fuel is in evidence, fire services should lay a foam blanket over the affected area. Foam and carbon-di-oxide lines can also be laid out at points of advantage and held in readiness during rescue operations.

6. **Gaining Access to Aircraft**.

(a) **General**-Entrance to aircraft differs with the purpose for which the machine is constructed. It can be accepted, however, that in the majority of cases where the fuselage space is utilised, such as in bombers, fighters, troop or passenger carriers, etc. a main entrance door is provided for normal traffic. To provide for crew exit in emergency "Emergency Exits", "Ditching Hatches", and "Parachute Escape" panels are available at points of vantage throughout the fuselage. In the case of single seater aircraft, as most fighters are, the only means of reaching the cockpit is via the canopy. There is seldom any alternative. While this. offers the rescuer a choice of entrances into large aircraft, it is recommended that the sequence described in the following paragraphs is practised, when possible, at the scene of a crash. Almost all aircrafts both service and civil are equipped with certain items of first aid and firefighting equipment. To advise rescue personnel the aircraft is so equipped, symbols in silhouette form are used. Details are given below:

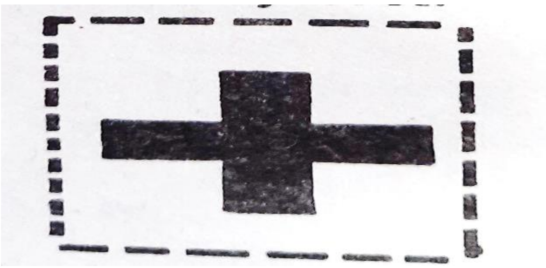
(i) **Fire Fighting Equipment**-The firefighting equipment is located inside the aircraft at a point near to the "SILHOUETTE" and is fitted onto a quick release bracket. A sharp pull will release the equipment. The fire extinguisher may of any following types:

(aa) Methyl Bromide Hand Fire Extinguisher.
(ab) Fire extinguisher charged with water glycol to prevent freezing.
(ac) Halon extinguisher.

(ii) **Crash Axe**-This type of axe is carried on most large aircraft. It is all steel with a specially designed face for cutting into metal. The handle is of rubber, insulated to withstand up to 25,000 volts. like the fire extinguishers, the axe (or axes) will be positioned in close proximity to the appropriate symbol.

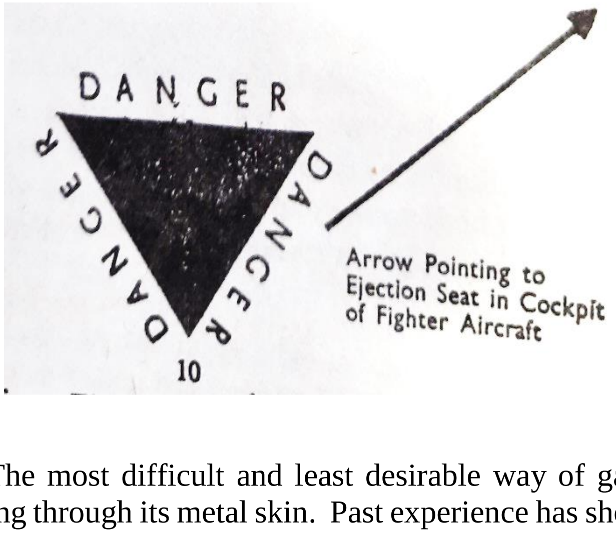
(iii) **Symbols** –

(aa) **Red Cross Symbol -** This symbol is self-explanatory, a red cross box will be found within the aircraft near this symbol.

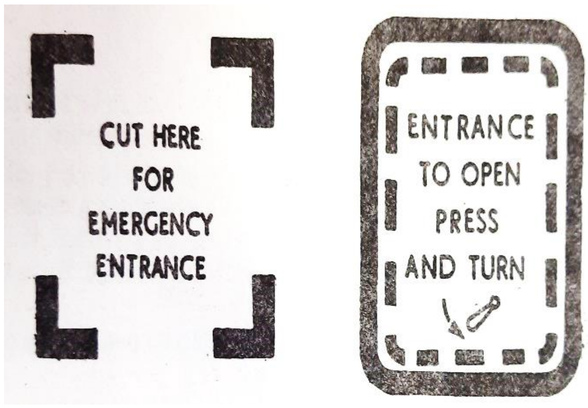


(ab) **Protective Gloves** – Gloves are included in certain aircraft. Like all the items of equipment mentioned in this chapter they are there to enable the aircrew to combat fire in the aircraft while in the air.

(iv) **Ejection Seat** – Aircraft fitted with ejection seats display a warning symbol on each side of the fuselage. The symbol is an equilateral triangle having 9-inch sides and is coloured red. The word "DANGER" is shown along each leg of the triangle and the words "EJECTION SEAT" are shown within. On fighter type aircraft this symbol may include an arrow, pointing to the head of the ejection seat, as an additional warning.



(v**) Break In Marking-**The most difficult and least desirable way of gaining entry in to a crashed aircraft is by cutting through its metal skin. Past experience has shown, however, that this method of entry has had to be adopted as a last resource. Break-in marking were therefore introduced as a guide to rescue personnel who may not be conversant with the structure of an aircraft or with the layout of the equipment carried. panels, or parts of an aircraft encircled by a broken or interrupted line have been purposely chosen as a position where rescuers could cut into a fuselage, encountering the minimum of obstruction. The marking are normally coloured yellow, but white and brick red are also used on black or light coloured aircraft. The colours are not a code. Rescue personnel requiring to cut into an aircraft must not deviate from these markings, otherwise airframe parts, fuel pipes, electrical cables, or oxygen circuits, etc. may be fractured possibly resulting in fire or explosion.



(b) **Main Entrance Door**.

(i) Try to gain entrance by using the main entrance door in the first instance. The door is indicated by the word "ENTRANCE" and has stencilled instructions on the use of the external release mechanism.

(ii) Door handles on modem aircraft are similar in design and operation to car door handles. They are normally housed within the door and flush with the fuselage skin. The handle flies out to thumb pressure on a small button situated in the tail of the handle. Turn or lift the handle as instructed, to open the main entrance door.

(c) **Emergency Exists.**

(i) Should the main entrance door fail to open, owing possibly to distortion, the "Emergency Exit" should be tried next. The words "EMERGENCY EXIT are displayed and instructions on how to release the panel are stencilled on the side of the fuselage.

(ii) "Emergency Exit" and "Parachute Escape" panels are designed to fall free of the aircraft when released and therefore are not hinged. An "Emergency Exit" panel must be kept under control by the rescuer until it is clear, in order to avoid unnecessary injuries.

(d) **Parachute and Ditching Escape Panels**-These panels are normally opened by the aircrew from inside the aircraft before leaving in emergency. The panels are externally marked with "interrupted lines" showing where access could be gained by cutting if necessary.

(e) **Perspex Windows**-Should entry fail by the "Main" or "Emergency Exits" the best way of gaining entry is by breaking through the Perspex or plastic windows. The following points should be emphasised regarding breaking through perspex:

(i) Never break through above or near to any member of the crew, thus avoiding the possibility of inflicting injury.

(ii) Never break through immediately above the head of a British "pilot ejection seat". The seat is always exposed and required only one half-inch of travel to explode the seat cartridges. The results can well be imagined.

(iii) Never break through Perspex, using uncontrolled force. This can result in the rescuer's wrist being lacerated on the broken and jagged edges of the lower section.

(iv) Break through just above the metal sill; use the flat in preference to the cutting edge; use the metal sill as a "stopper" to prevent the axe "following through". This will prevent injury to the user.

(v) If necessary, cut the entire Perspex panel from its metal frame.

(vi) In certain modern aircraft laminated Perspex may be encountered: this is virtually unbreakable and time should not be wasted in trying to force entry by this means.

(f) **Canopy Jettison Levers**-Before aircrew can be ejected from an aircraft, the cockpit canopy must first be jettisoned. This is done by the operation of either a lever or a switch within the cockpit as follows:

(i) **Jettison Levers (Manual).**

(aa) Manually operated jettison levers on British built aircraft are coloured black and yellow. The colours run in diagonal lines or stripes and in some cases are conspicuous by the addition of a green luminous plastic strip.

(ab) The jettison levers, or cords, are situated in the cockpit within easy forward reach from the pilot's seat.

(ac) **Warning**-It is not recommended that internal jettison levers on American or Canadian aircraft are operated; certain canopies "blow off" with considerable force and could cause severe damage to the rescuer.

(ii) **Explosive Bolts-Jet Bombers Only**

(aa) Canopy locking bolts in most jet bombers are broken or severed by means of small explosive charges fired by an electrical switch operated by the pilot.

(ab) Rescue personnel cutting round the metal edge of a bomber canopy may strike and explode one or more of the detonators. This would not cause harm or damage to either the crew or rescuer. If all the detonators exploded, the canopy would rise about 4 inches and would be detached from the fuselage. It can then be pushed over the side of the aircraft.

(ac) A bolt exploding, would give a small report accompanied by a puff of smoke which would do no harm.

7. **Removal of Crew and Passengers.**

(a) **Removal of Pilot**-Having gained access to the aircraft, the safe removal of the crew becomes the all-important job. If the aircraft is fitted with a pilot ejection seat, the seat must be made safe before any attempt is made to rescue the pilot. The actions detailed in the following paragraphs must be carried out in sequence to remove the pilot.

(b) **Face Mask**

(i) In certain aircraft the pilot requires oxygen from the time he takes off until he returns. In this case the rescuer would find the oxygen mask in position. i.e. covering the pilot's mouth and nose.

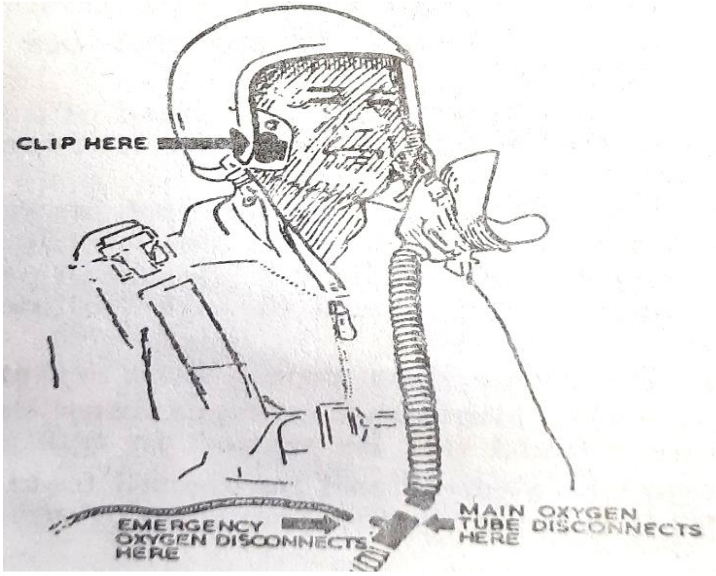
(ii) The mask is removed by unclipping it from a small hook fitted to each side of the helmet.

(iii) In order to ensure easy breathing and allow the pilot to speak if conscious, the face mask must be removed at once.

(c) **Main and Emergency Oxygen Tubes.**

(i) The main oxygen tube attached to the face mask can be easily disconnected by pulling a "slip fit" coupling apart. The coupling is situated about 18 inches down from the face mask. Place the left hand below and the right hand above the coupling and pull to disconnect. The mask and tube will now be free and can be discarded.

(ii) The emergency oxygen tube (about 3/8 inch in diameter) is connected at right angles to the main tube and is disconnected by pulling down on a small, metal spring loaded sleeve.



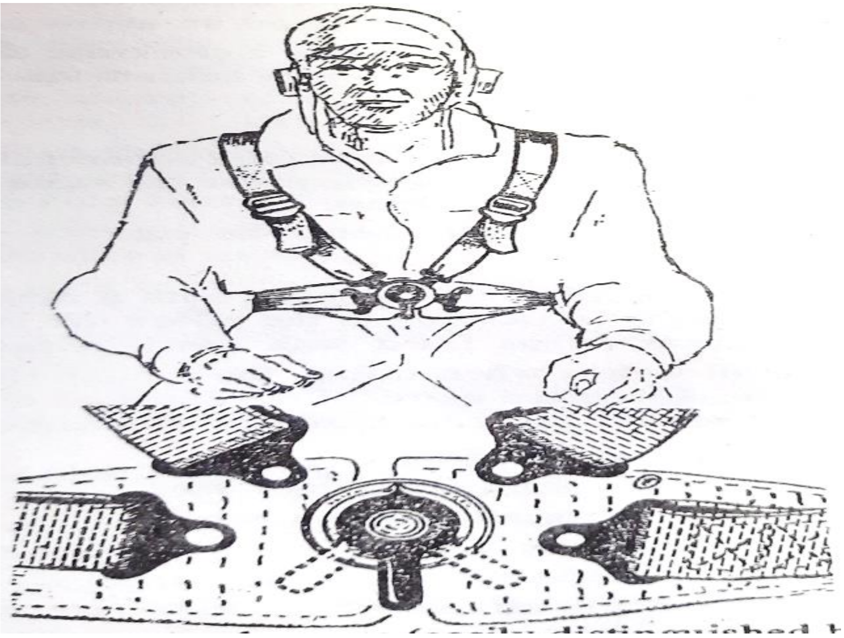
(d) **Wireless Telephone (W/T).**

(i) The W/T cable attached to the pilot's helmet is connected by a male and female plug. A slight pull on the cable disconnects this union.

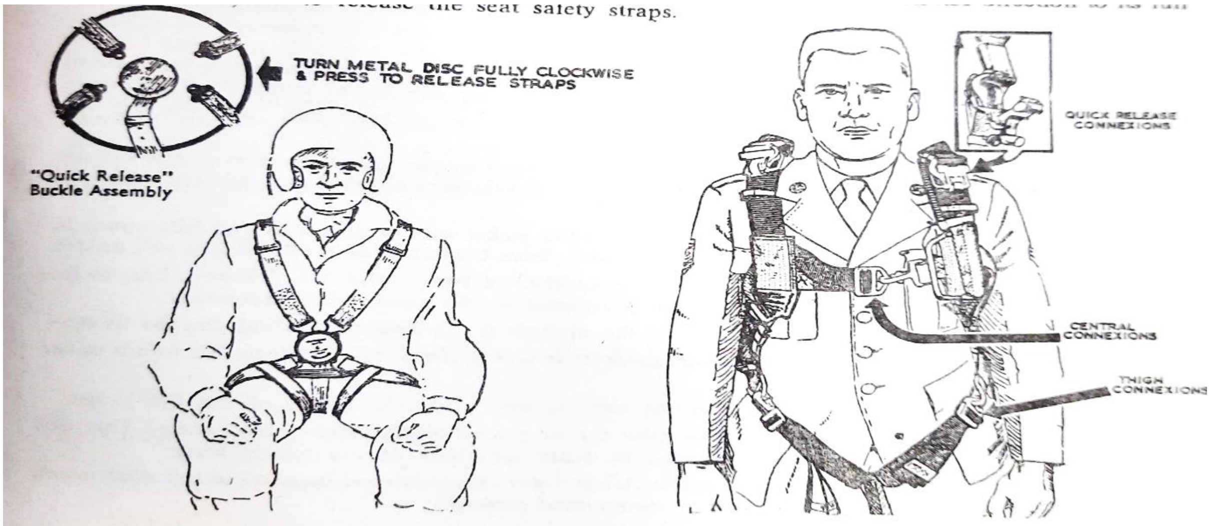
(ii) Any other cables leading forward to the cockpit facial panel will disconnect at a sharp pull.

(e) **Seat Harness.**

(i) A pilot is normally strapped into his seat by four strong webbing straps. Irrespective of design or country of origin, seat harness has one common feature; it is undone by the manipulation of a "quick release" buckle, fastener, or catch. The buckle is situated centrally over the pilot's stomach. Seat safety harness is over all other straps or connections.



(ii) "Martin Baker" ejection seat harness (easily distinguished by its blue-coloured straps) is held together by a quick-release buckle. A small lever protrudes from the top of the buckle pointing upwards. Turn this lever downwards in a clockwise direction to its full extent to release the seat safety straps.



(f) **Parachute Harness**

(i) The locking device and straps of the parachute are not unlike the seat harness in design and likewise have a quick-release buckle. The buckle is in a central position over the pilot's stomach. The assembly consists of a square metal box, into which the straps are inserted, and a round metal disc to lock or unlock the straps as required. The plate displays the words "TURN TO UNLOCK" and an arrow points in a clockwise direction.

(ii) To disconnect the harness, turn the plate in a clockwise direction to its full extent; place both thumbs on the plate and the fingers behind the buckle; press firmly with the thumbs, and the straps will disengage.

(g) **Anti 'Gravitation Suit Connection**

(i) In certain aircraft, corrugated rubber tubes are connected to the pilot's clothing for the passage of pressurized air. The connections are the same as fitted to the oxygen system and are disconnected by pulling apart.

(ii) Any rubber tubing giving trouble should be cut.

(h) **Dinghy**

(i) The majority of fighter aircraft are equipped with a rubber dinghy on which the pilot normally sits. The dinghy is attached to the pilot's life jacket (Mae West), normally by three lightweight canvas straps fitted with quick release clips.

(ii) To reduce the overall weight when lifting, the dinghy should be disconnected. This is done by gripping the corrugated barrel of the clip with one hand and the strap with the other, pull downwards on the clip until the connection is broken.

(i) **Connections in the Sequence of Breaking**

(i) Remove the oxygen mask from the pilot's face.
(ii) Disconnect main and emergency oxygen tubes.
(iii) Disconnect wireless telephone cable.

(iv) Disconnect seat safety straps.
(v) Disconnect parachute safety straps.
(vi) Disconnect dinghy straps (three).
(vii) Disconnect anti-'G' suit tubes if fitted.

NOTE-A small diameter rubber tube may be fitted to the pilot's life jacket. This can be disconnected in the same manner as the emergency oxygen tube.

(k) **Removal from Cockpit**

(i) Do not attempt to lift the pilot until certain that his feet and legs are free from obstruction. His feet may still be held by the rudder bar stirrups or trapped by wreckage.

(ii) The position to take to lift a pilot from a cockpit can be one of the following:

(aa) If the canopy is free of the cockpit, the No. 1 rescuer places his feet on the canopy guide rails behind the pilot's shoulders, first having ensured that the seat safety pin is through the seat.

(ab) No. 1 grips the collar of the pilot's life jacket with both hands and lifts upwards. No. 2 rescuer, working from the side, places his hands under the thighs and ankles.

(ac) No. 1 eases the pilot over the shoulders of No. 2, and No. 2 lowers him to the ground gently. Other rescue personnel would assist when necessary.

(iii) If the canopy is still attached to the aircraft the following method can be used: -

(aa) No. 1 stands on the canopy guide rails facing the pilot and places his hands under the pilot's armpits.

(ab) No. 2 kneels or sits on the canopy and grips the collar of the life jacket.

(ac) Both rescuers lift until the pilot can be placed on the edge of the canopy. The pilot can then be gently lowered to other members of the rescue team.

Warning-It is of the utmost importance that switches levers, or any other mechanism inside the cockpit of any aircraft, are NOT interfered with or operated in any way by inexperienced personnel.

CARE OF CREW

8. (a) **General**-The actions and/or precautions detailed in the following paragraphs should be taken to ensure the safety and comfort of the casualty after he has been removed from the aircraft.

(b) **Removal of Casualty** -Carry the casualty gently to an up-wind and up-hill position at least 50 yards from the aircraft.

(c) **Inspection of Clothing**-Inspect the casualty's clothing for:

(i) **Saturation**-If it is found that his clothing is contaminated or saturated with fuel make sure that all concerned are warned of this danger. Outline the affected parts with chalk if available so that the condition can be readily seen and the danger appreciated.

(ii) **Smoulder**-Inspect the clothing closely, especially the under parts which would be nearest to the cockpit floor. If exposed to any draught, smoulder will quickly be famed into flame and cause grievous bodily harm.

(d) **Treatment for Shock**-Keep the casualty as warm as possible. Do not lay on damp grass. Use the parachute as a bed or blanket if necessary.

(e) **Crash Helmets**-If a plastic crash helmet is worn, grip the sides of the pilot's chin, spread the helmet apart and case gently off. Do not remove the soft leather flying helmet covering the head. If head injuries have been received, this helmet will act as a pad and help to stop the flow of blood until proper medical aid can be obtained.

(f) **Smoking- Do not offer or give cigarettes**-The casualty may have severe internal injuries which could be aggravated by tobacco smoke. His clothing may also be saturated by high octane fuel.

(g) **Burning Clothing**-If a pilot's clothing is alight try to smoother the flame, wrap in a blanket or use handfuls of damp grass or earth. Do not tear off burning clothing as this tends to remove flesh from the casualty and may result in the rescuer suffering badly burned hands. Use any of the fire extinguishers previously mentioned but care must be exercised in the use of methyl bromide.

(h) **Injuries**-In the absence of trained medical staff, first aid treatment should be limited to stopping the flow of blood. The red cross kit should be obtained from the aircraft and used to the limit of the rescuer's knowledge.

(i) **Casualty Label**-If available, obtain and fill up a casualty label as completely as possible. If no label is available, use an old envelope or page from a note book to give as much detail about the casualty's condition as possible. Rather include too much than too little. If the rescuer is thoroughly familiar with medical symbols, ie. X for unconscious; M for morphine; T for tourniquet, etc. he should use them. Do not use these symbols unless they are understood.

9. **Conclusion**-Rescue from civil aircraft may be a prolonged operation bearing in mind the numbers that may be involved and the fact that they may not all be able bodied. The rescue must be carefully organised and it must not be forgotten that operational space is limited. The number of rescuers entering the fuselage must be kept to a minimum. Rescue procedure should progress on a "chain" principle with all walking cases being evacuated first. All civil airline crew personnel, male or female, are drilled in rescue procedure and their guidance should be followed without question.

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CHAPTER 23

CARE AND PRESERVATION OF STORES

1. **Introduction**

Efficiency of any organisation during crisis situation depends not only on its professional knowledge, practice and structured drills but also to a large extent on the state of equipment and stores it is required to handle to achieve its task. The role of Civil Defence during hostilities or any crisis of mitigating and reducing suffering of people and loss to national property would come to a grinding halt if the equipment carried by various Civil Defence services are in a state of deterioration or defective at the point of application. It is, therefore, necessary that utmost care should be ensured by all concerned to keep the equipment and stores in the highest state of functional worthiness.

CARE AND PRESERVATION OF STORES AND EQUIPMENT

2**. Rescue Equipment**

Rescue is one of the most important tasks allotted to the Civil Defence organisation during crisis. The equipment for the rescue teams has to be procured both for training and for use during actual hostilities or disasters, preservation of such equipment is therefore of paramount importance. The following aspects need to be considered for preservation of rescue equipment:-

(i) **Ladders**-These are liable to deteriorate due to exposure to weather and mechanical stress while in use. Ladders should not be painted as by so doing it tends to conceal cracks which might ultimately result in an accident. Emphasis should be more on use of non-corrosive aluminium extension ladders. When in storage, exposure to direct sun rays should be avoided, as it leads to weakening of the nylon extension cord and cracking of rubber paddings.

(ii) **Ropes and Lines**-Manila ropes are frequently used in Civil Defence for rescue work. While no particular treatment for ropes is necessary, it may be treated with creosote against any attack by termites. During storage anti-termite dunnage should be provided.

(iii) **Pulley Blocks and Chain Tackles**-The bushes of the pulleys should be treated with grease. LG-280/grease XG-280 and the sheave should be painted Chain tackles should be cleaned with oil, kerosene or white spirit and grease applied on working parts and non-working surfaces painted.

(iv) **Stretchers**-These should be stored in a dry place and promptly repaired for any minor damage. The locking pins and hinges may be duly oiled. The canvas of the stretcher should be brushed or sprayed with 10% Copper Nephthanate solution in white spirit. The dunnage for stretchers too should be anti-termite.

(v) **Rescue Chute-**The canvas chute should be stored in a dry place on an anti-termite dunnage and treated with 10% Copper Nephthanate in white spirit as for stretchers.

(vi) **Blankets**-These should be kept in an airtight package or almirah with Nephthalene balls or powder evenly spread at the rate of 1 kg per cubic meter. Half yearly checks need to be made for investigation and replenishment of Nephthalene balls/powder. Blankets should be stored on anti-termite dunnage.

(vii) **Boots Rubber**-These need to be dusted with French chalk and when in storage kept in air-tight polythene bags. When possible, the temperature should be controlled at 27° C and circulation of air restricted. Storage rooms should be dark and strong lights must not be permitted to fall on the rubber boots.

(viii) **Axis Pick Hammer Crow Bars etc.-**These should be coated with grease GS or oil preservative Engine SAE-30. Halves should be treated with mixture of creosote and raw linseed oil in the ratio of 20:80 by 48 hours cold soak method.

(ix) **Major Equipment**-Instructions provided by the supplier with regard to maintenance of these should be strictly followed in addition to maintenance instructions given for each major equipment in this manual.

FIRE FIGHTING EQUIPMENT

(i) **Delivery and Suction Hose**-Deterioration of the hose can be caused by abrasions, mildew, shock and contamination by acids, alkalis, oils and paints. After use they should be cleaned, dried and stored in a cool, dry place on wooden rungs made specifically for their protection from termites and surface temperatures. For rot proofing. 10% Copper Nephthanate solution in white spirit should be spread on the hose. Rubber lined hoses should be stored in dark and cool place with temperature, if possible below 32° C. Not more than 3 to 4 loose coiled rubber hoses should be stacked one above the other. The rubber washer of the suction hose should be kept soft and pliable by periodic application of dubbin. It should be dusted with French chalk on the outer surface.

(ii) **Suds Acid Extinguisher**-Periodic inspections and testing must be carried out regularly as per instructions given in the Fire Drill Manual. Vent holes in the cap, nozzles and snifter valves should be inspected and kept clear of dust, metal corrosion and metal polish etc. When replacing plunger rod, it should be lightly greased and washer examined. Refills of sulphuric acid should be stored on steel trays placed on the bottom shelf or on the floors.

(iii) **Foam Type Extinguisher**-The contents of inner and outer containers should be stirred with separate sticks.

(iv) **CO, Extinguisher**-These are generally available in pressurised containers and should be tested periodically by releasing gas. Check for blocked vents and nozzles.

(v) **Dry Chemical Powder Extinguisher**-Periodic testing must he regularly ensured, refills not in good condition replaced and plunger lightly greased.

(vi) **Stirrup Pumps**-These should be stored in a cool, dry place and preferably hung on the walls. After use, the plunger, nozzles and outer casing should be dismantled, completely dry and thick coating of grease applied before storage. These pumps should not be used for spraying chemicals, corrosive in nature.

TENTS

Following precautions may be ensured

(i) When pitched the flies should not touch the ground and the outer fly should not touch the inner fly.

(ii) Detachable walls should not sag or lean against inner flies.

(iii) Earth should not be banked up against the walls.

(iv) Leaves, twigs, dust and bird droppings should not be allowed to accumulate on tents.

(v) Ropes should be slackened during rains and at night during heavy dew falls.

(vi) 10% Copper Nephthanate solution in white spirit should be brushed on erected tent walls up to 30 cms over lower edge against damage from termites and mildew. Same treatment should be carried out to the ropes.

(vii) The standing poles of the tent should be soaked in mixture of Creosote oil in the ratio of 50:50.

RESPIRATORS

(i) Respirators should be stored in their haversacks/original boxes/packing cases in a clean, dark, dry, cool and well ventilated place.

(ii) Stacking of respirator cases should be restricted to five layers.

(iii) Sharp bends or folds should be avoided.

(iv) Holder valves should not be subjected to any mechanical deformation when packed.

(v) French chalk should be liberally applied on all rubber parts. (vi) It should be ensured that the eye-piece, buckles and loops made of metal do not lose their protective coating of lacquer or paint.

3. **Conclusion**

Suggestions contained in this chapter with regard to the preservation and storage of equipment generally used by Civil Defence personnel are as a guide and not exhaustive in nature. There is a requirement of personal concern on part of the user to avoid deterioration of equipment used by them. These drills may be constantly revised and instructions supplied by the manufacture with regard to any particular equipment must be strictly adhered to.

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