FM 55-15

TRANSPORTATION REFERENCE DATA

HEADQUARTERS, DEPARTMENT OF THE ARMY

PCN 32005515300

Field Manual
No. 55-15

Headquarters
Department of the Army
Washington, DC, 27 OCTOBER 1997

TRANSPORTATION REFERENCE DATA

TABLE OF CONTENTS

DISTRIBUTION RESTRICTION: Approved for public release; distribution is unlimited.

*This publication supersedes FM 55-15, 9 June 1986.

PREFACE

This manual is both a planning guide for staff and unit officers and a digest of operational data for reference by operators and users of transportation. It gives characteristics of typical transportation equipment and facilities and methods for estimating capabilities and requirements for transportation equipment, facilities, and troop units. It provides personnel and equipment data for the modes of transportation and for transportation terminals; and data for computing requirements for staff, supervisor, and control activities. It also addresses administrative support requirements.

This manual contains report formats and examples of orders and standing operating procedures; loading data for water, rail, motor, and air movements; tables on weights, measures, and conversion factors; and miscellaneous information of general usefulness. Planning data contained herein may be modified as necessary to meet known conditions and requirements.

The Army's environmental strategy into the 21st century defines our philosophy and commitment in protecting and preserving the environment and natural resources for present and future generations. Sound environmental practices and considerations must be integrated into all Army documents, missions, and operations. In keeping with the Army's vision to be a national leader in environmental stewardship, commanders and leaders must ensure that all local, state, federal, and host nation laws and regulations pertaining to the environment are included in the planning process and strictly followed.

The proponent of this publication is HQ TRADOC. Send comments and recommendations on DA Form 2028 (Recommended Changes to Publications and Blank Forms) to Commander, USACASCOM, ATTN: ATCL-AT, Fort Lee, VA 23801-6000.

Unless otherwise stated, whenever the masculine gender is used, both men and women are included.

CHAPTER 1
MOVEMENT CONTROL

This chapter discusses key elements of movement control, including movement programming and highway regulation. See Appendix A for transportation movement control unit TOE data.

ELEMENTS OF MOVEMENT CONTROL

Movement control is the planning, routing, scheduling, coordinating, and in-transit visibility of personnel, units, equipment, and supplies moving over the lines of communication. Movement control requires the commitment of allocated transportation resources in keeping with command priorities. Staff planners and movement managers have primary responsibility for movement control. They, along with mode and terminal operators at each level, perform movement control functions.

Movement Control in the Communications Zone

In a theater army, the TMCA, subordinate transportation battalions (MC), and their MC detachments perform movement control functions. The TMCA serves as executive agent and primary staff element to the theater commander for planning and controlling theater transportation operations. It provides movement management services and highway regulation and coordinates personnel and material movements into, within, and out of the COMMZ or lodgment area. TMCA responsibilities include–

- Coordinating with HN and allied MCAs and transportation component commands.
- Providing technical assistance to corps MC battalion.
- Ensuring proper use of available HN and military transportation assets.

Chapter 3, FM 55-10, details TMCA missions and functions.

Movement Control in the Corps

The transportation battalion (MC) is the corps movement control organization. It provides centralized movement control and highway regulation for moving personnel and materiel into, within, and out of the corps area of operations. Responsibilities of the MC battalion include–

- Ensuring effective and efficient use of transportation resources.
- Commanding and supervising subordinate MC detachments.
- Planning, programming, coordinating, managing, and analyzing transportation and movement requirements.
- Implementing corps priorities.
- Maintaining liaison with higher-level MC organizations.

FM 55-10 discusses the role of transportation movement management within the corps.

Movement Control in the Division

The DTO and the DISCOM MCO manage the division transportation system. The DTO advises the commander on transportation matters and highway regulation. A division support MC detachment from corps augments the DTO. The MCO programs movements and performs transportation support functions for the division. See FM 55-10 for more information.

MOVEMENT PROGRAMMING

The movement program is key to planning both known and anticipated transportation requirements for reception, onward movement, and sustainment. A complete, well-prepared movement program allocates available transportation resources to support requirements based on the commander's priorities. It establishes which requirements can be resourced given available logistic assets, units, and infrastructure. In doing so, it effectively uses these assets and identifies competing requirements and shortages. The seven steps in developing a movement program are–

- Assessing the distribution pattern.
- Determining requirements.
- Determining transportation capabilities.
- Balancing requirements against capabilities.
- Determining shortfalls and critical points and recommending solutions for handling the shortfalls.
- Coordinating the plan.
- Publishing and distributing the plan.

Assessing the Distribution Pattern

Understanding the distribution pattern is essential to developing a transportation network. Also, intelligence and engineering data about the area of operations are needed to determine network capabilities.

The distribution pattern is a complete logistic picture that constantly evolves as the theater/area develops. It shows locations of supply, maintenance, and transportation. The distribution pattern's development is guided by the commander's concept of the operation; the number, type, and location of in-place and incoming units; and the time-phased arrival of units in the theater/area. The distribution pattern outlines throughput and interzonal transportation requirements that directly affect the coordination and preparation of movement programs.

The capability of shippers and receivers to receive, handle, and load various transportation modes also affects the movement program. This capability is determined by availability of MHE, CHE, ramps, labor, and storage capacity. Information on current capability is necessary for the efficient scheduling of transportation and to prevent congestion.

Determining Requirements

Accurate requirements are key to developing an effective movement plan. Requirement forecasts must be submitted far enough in advance for the transportation and supply systems to adjust their resources to carry out the plan.

Requirements are forecast using specific planning periods. The number and speed of experienced or anticipated changes influence the length of these periods. A 14-day planning period allows a firm forecast of requirements for the current 7-day period and a tentative forecast for the succeeding 7-day period. This method provides a basis for operations during the current period and for planning during the succeeding period. When using a 14-day planning period, a new planning cycle is initiated every 7 days. An ADP system that integrates movement and supply information improves the accuracy of both forecasts and movement programming.

Class of supply, estimated weight and cube, RDD, and planned origin and destination are important in determining materiel movement requirements. The list is grouped by RDD, priority, origin, and destination and identifies special handling requirements. These include refrigerated cargo, hazardous cargo, and controlled or sensitive cargo. Personnel movement estimates are grouped by category, such as troops, civilians, patients, or prisoners of war.

Determining Transportation Capabilities

The characteristics and capabilities of mode and terminal operators determine transportation capabilities.

Other information that contributes to the total transportation capability includes:

- Availability of equipment to support common-user movement requirements, such as engineer, combined forces, and supply company assets.
- Total number of HN transportation assets and types allocated to support common-user movement requirements. (Include rail, inland waterways, and coastal shipping if available and feasible.)
- Number and type of third country and US-contracted assets.
- Reception, material handling, and in-transit storage capabilities.

Intratheater/theater US Air Force airlift and airdrop may be planned for if the JTB or JMC allots assets for CSS air movement operations to the theater army. The theater army commander allocates apportioned airlift based on command priorities.

When developing transport capabilities, use planning factors or experience based on the type of equipment, availability of MHE and CHE, weather, and terrain. Use planning factors from this manual when information from mode operators is unavailable.

Balancing Requirements Against Capabilities

Balancing requirements against capabilities helps to determine whether available mode assets will support movement requirements. Planners must consider all requirements including direct shipments, multiple stops, retrograde shipments, and intermodal shipments.

If there is a transportation shortfall, movement planning should focus on command priorities and the transportation priority of the shipment. The remainder should be adjusted and coordinated with the shipper, receiver, materiel managers, and logistic staffs.

Determining Critical Points

Critical points are facilities, terminals, ports, railheads, and cargo transfer points that, if congested, limit the efficiency and effectiveness of the entire transportation network. After identifying the critical points, determine alternative plans or control measures that could reduce or eliminate risk of congestion.

Selecting a Transport Mode

Certain criteria should be considered when selecting a mode of transport. Follow these guidelines to achieve the best results:

- Provide service according to command and transportation priority. Evaluate other factors, such as shipment characteristics, security requirements, and political considerations.
- Minimize or eliminate cargo rehandling, avoid crosshauls, and plan for backhauls.
- Allocate all available transport equipment necessary to fulfill known requirements.
- Use the most efficient mode for the complete movement or as far forward as possible.

Coordinating the Movement Plan

To integrate planning and synchronize execution, the movement plan should be coordinated with movement planners at each command level both during and after development. So that all players understand their roles and responsibilities, the plan should also be coordinated with operations, supply, military police, engineers, and Air Force staffs.

Publishing and Distributing the Plan

Movement control organizations distribute the completed movement plan to each command level for comment and concurrence. During this phase, the plan facilitates planning. It also shows evolving distribution patterns and projected logistic activity. It does not authorize shipments to take place. The movement plan becomes a directive only when approved by the DCSLOG or G4.

HIGHWAY REGULATION PLANNING

The objectives of highway regulation planning are sustained movements in keeping with the commander's priorities and the most effective and efficient use of road networks. Planning is done in a logical sequence and results in publication of the highway regulation plan and the traffic circulation plan.

Assembling Information

The first step in planning is to assemble critical information. Sources of information include operations plans and orders, engineering and intelligence plans or estimates, traffic density information, and terminal and facility data.

Operation plans, orders, and estimates. Operation plans, orders, and estimates contain essential information that must be read and understood. Movement planners must understand the concept of operation to effectively support the commander's intent while executing highway regulation. These plans also contain information such as geographic boundaries, task organization, priorities, and location of major supply activities. See Appendix B for sample plans and orders formats.

Engineering and intelligence plans or estimates. Engineer route reconnaissance or classification overlays provide detailed information on road network characteristics (such as, road surface, width, restrictive features, and bridge classifications). This information is needed to determine critical points and route capacity (see FM 5-170).

The route classification formula contains route characteristics. Although current information is needed, a thorough route reconnaissance may not always be feasible. Aerial photographs, local authorities, intelligence reports, and MP hasty route reconnaissance are other sources that can supplement data obtained from maps or intelligence studies.

Traffic density information. Traffic density information is the anticipated volume of traffic on route segments during specific periods. It comes from planned requirements contained in the movement program, the OPLAN or OPORD, or FRAGOs. Planners must extract specified and implied requirements for unit movements, sustainment movements, and retrograde movements. These documents may also require moving civilian refugees, unit displacement, or shared use by allied or HN forces. Each type of movement must be prioritized, planned, and synchronized.

Terminal and facility data. Terminal and facility data include the location of supply points, trailer transfer points, terminal transfer points, staging and assembly areas, aerial ports and seaports, airfields and drop zones, and refueling points. All facilities are considered in terms of their total clearance and reception capabilities. Factors considered include location; access from MSRs; and capability to receive, load, unload, and stage.

Identifying Road Networks

Once data has been assembled and studied, road networks are identified. Road networks must be able to support the volume of traffic necessary to meet planned and anticipated movement requirements. Primary and alternate MSRs must be recommended. The forward movement of maneuver forces should be anticipated and MSRs extended well beyond the current area of operation. ASRs are used when the primary MSRs are disabled; thus, ASRs should be planned for in the same way as MSRs. At this point, planners must get the approval of the G4 and G3. The G4 has staff supervision for movement planning. The G3 is responsible for terrain management and must approve the selection of MSRs before movement planners can conduct detailed highway regulation planning.

Developing the Plans

Once the G3 approves the MSRs and ASRs, the highway regulation and traffic circulation plans are developed. The highway regulation plan is a written plan that describes the MSR network and establishes control measures to promote effective regulation. The traffic circulation plan is a map overlay or graphic representation of the MSR network. Both plans are published as an appendix or annex to the OPLAN or OPORD and are used by the PM to develop the traffic control plan. The following steps are basic to developing highway regulation and traffic circulation plans.

Name each MSR according to command directives. Avoid using colors to name MSRs because MSR status, along with other logistics status, is usually reported as green, amber, red, or black. Avoid using numbers to name MSRs because they may conflict with existing route numbers.

Determine critical points. Plans do not list every critical point—only the most important ones that may affect traffic flow. Critical points include:

- Roadway structures or features that limit road width, overhead clearance, or vehicle load class. For example, washouts, overpasses, bridges, and degraded road surface conditions.
- Crossroads at grade level.
- Bridges, overpasses, underpasses, ferries, fords, constrictions, and sharp turns under a 30-meter (l00-foot) radius.

Establish CPs on each MSR to segment the MSR. Segmenting the MSR facilitates highway regulation and traffic control planning and execution. CPs should be established at predetermined points along the route, such as:

- Major crossroads.
- Locations where road conditions change.
- Major supply or service areas, geographic boundaries, assembly areas, and other critical points.

Units use CPs when requesting movement clearance, identifying the unit SP, RP, and en route CPs. CPs are also used when describing the MSR in the highway regulation plan (such as, "MSR Walnut is a supervised route between CP 3 and CP 6 between 0600 hours and 1200 hours"). CPs enable quick dissemination of information during execution, such as a point where traffic will be rerouted. Sufficient CPs should be identified, but no more than operating and control units have the capability to manage. Excessive CPs will impede execution of the plan.

Establish control measures for each route. Planners should base control measures on engineer route classifications, planned and anticipated traffic volume, METT-T, and critical points. They must also consider the capabilities of movement control and traffic control units to enforce the measures. Control measures change frequently, and movement planners must ensure that these changes are incorporated into FRAGOs or otherwise quickly disseminated.

Open route. This is the least restrictive control measure. Any unit may use the route without a movement credit. Minimum control is exercised.

Supervised route. The movement control headquarters specifies the size of convoys or characteristics of vehicles that require a movement credit to use the route. Limited control is exercised.

Dispatch route. A movement credit is required to use this route regardless of the number or type of vehicles. A dispatch route is designated when traffic volume is expected to exceed capacity or the route is critical to operations and priority of use must be strictly enforced. Full control is exercised.

Reserved route. The route is reserved for the exclusive use of a particular unit(s) or type of traffic. No other units or traffic may use the route. Reserved routes should be identified for large unit movements. Examples include the following:

- When a maneuver unit must pass another forward.
- When reserve formations are committed.
- When units are withdrawn for reconstitution.

Prohibited route. The route is closed and no unit/traffic may use the route. A route may be prohibited due to washouts, destroyed bridges, maintenance, or construction work. It may be prohibited for only short periods, such as the time necessary to do repairs.

Create a traffic circulation plan. This overlay (Figure 1-1, page 1-6) shows all MSRs, checkpoints, and HRPs. It also includes route names; direction of travel; location of boundaries; principal supply activities; any restrictive route features, critical points, and rest and refuel areas; and traffic control points (if provided by the PM before publication of the plan).

Determine reporting requirements for units using the MSR. (If reporting is necessary to effectively execute the plan, and if communications are available.)

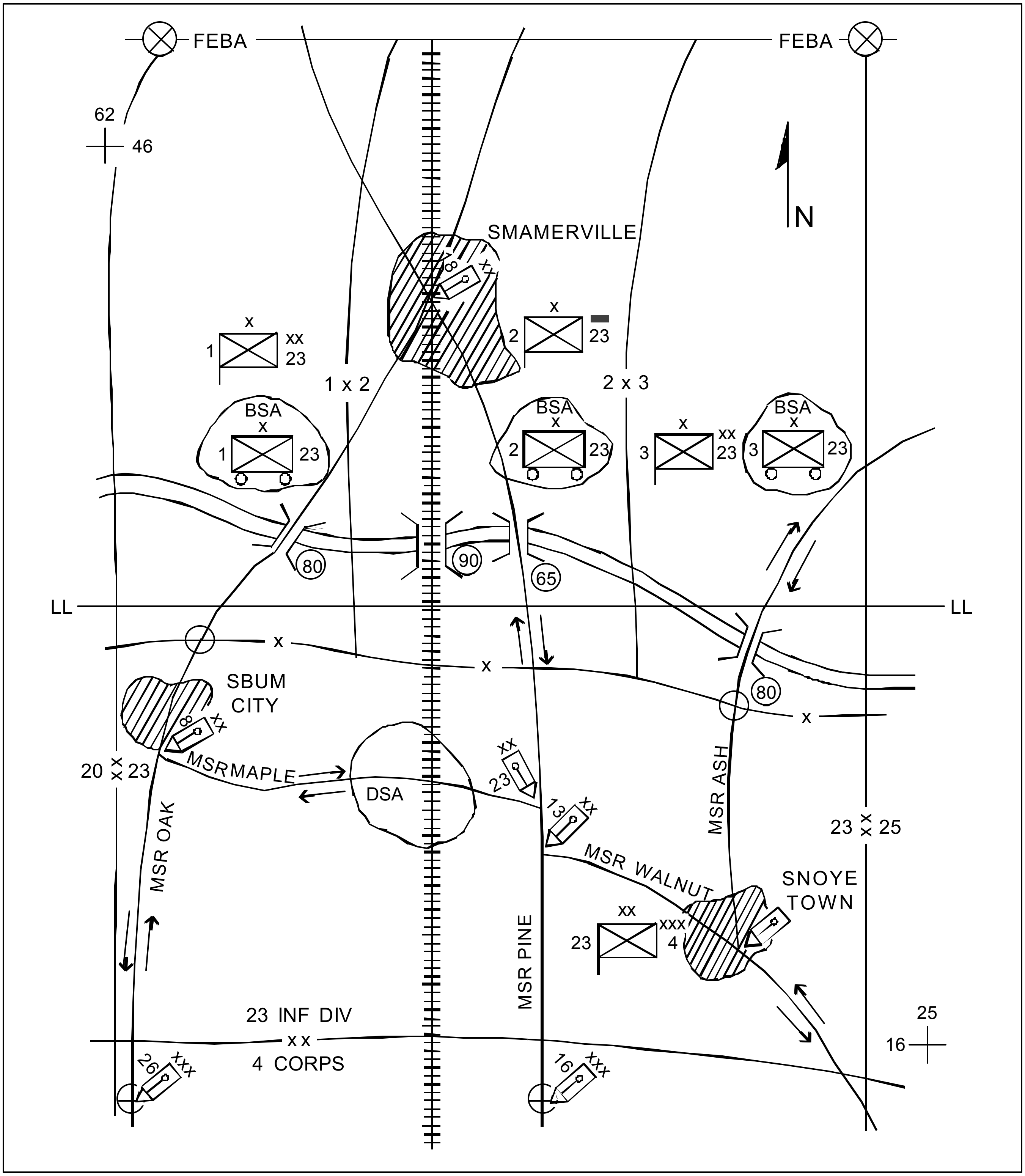


Figure 1-1. Sample traffic circulation plan

Develop the highway regulation plan and include it in the OPLAN or OPORD. The written plan describes information contained on the overlay. It also specifies the control measures that apply to each MSR or to critical segments of MSRs. If determined in advance, control measures should be coordinated to phases of the operation. These should be coordinated with the G3 – especially the requirements for reserved routes to support large unit movements.

Staff and coordinate the plan. Recommend points that require traffic control, as well as locations and priorities for engineer repair and upgrade efforts.

Once all procedures are implemented, planners must assess the availability of communications equipment to support highway regulation. Communications is always a constraint. However, careful planning will ensure that its use is weighted to routes identified as requiring the most control. Control is governed by the planned and anticipated traffic volume and the relative importance of preventing congestion on these routes.

FUNDAMENTALS AND METHODS OF SCHEDULING

Scheduling is the process of coordinating times for road movements. It involves receiving movement bids (requests), deconflicting the requests, and issuing credits (clearances). Scheduling is necessary to–

- Apply command priorities.
- Apply the fundamentals of routing to minimize delays, conflicts, and congestion.
- Conduct detailed planning for large unit or high-priority movements.
- Reserve time for route maintenance.
- Reroute or hold movements based on changes in priority or the tactical situation.

Scheduling Guidelines

It is important to follow certain guidelines when scheduling movements. For example, movements on routes requiring a movement credit must be scheduled. Also, movements that cross movement control boundaries must be scheduled, coordinated, and inbound-cleared. These functions are accomplished by the movement control organization responsible for the area where the movement originates to the movement control organization where the movement terminates. Other important guidelines are as follows:

- Large unit movements should be scheduled.
- Movements in one direction on routes that require a movement credit are treated as a single movement regardless of the distance or time involved. Each movement retains the same movement credit to destination.
- Schedules and changes to schedules due to immediate movement requirements are given to the MRTs to execute highway regulation and to the PM to provide traffic control.

Types of Schedules

The method of scheduling road movements is based on the control measures specified for the route. The four types of schedules (ranging from the least to the most restrictive) are infiltration, route, location, and column.

Infiltration. An infiltration schedule is a rate of dispatch assigned to units for specific routes and time blocks. The desired result is an average traffic flow that is within the capacity of the route. By assigning rates of dispatch to different units that need to use the same route, average traffic flow can be held within desired limits. An infiltration schedule may be used for open or supervised routes.

Route. The route schedule is a flexible scheduling method. It apportions blocks of time on MSRs to units, types of movements, phases of the operation, or for route maintenance. A route schedule may be used for supervised, dispatched, or reserved routes.

Location. A location schedule is more restrictive than an infiltration or route schedule. It assigns arrive and clear times to different units that need to use the same entry point onto MSRs. The location is normally a checkpoint. For example, at a particular checkpoint, Unit A may be scheduled to arrive at 1000 hours and to clear at 1015, Unit B to arrive at 1020 and to clear at 1030, and so on. A location schedule may be used for supervised or dispatch routes.

Column. The column schedule is the most restrictive scheduling method. It specifies arrive and clear times at CPs along an entire route. It is based either on the requester's movement bid or movement table or on movement tables issued by the movement control organization. A column schedule can be the most effective method of highway regulation. It provides in-transit times to reach CPs and helps the pacesetter to maintain the prescribed rate of march. It may be used for supervised, dispatch, or reserved routes. It should be used when congestion is anticipated.

As a rule of thumb – the longer the time and distance involved, the more restrictive the method of scheduling should be.

MEASURING MOVEMENTS

Movements are measured by calculating how long it takes to move a given distance. The three methods of measurement are speed, pace, and rate of march. They are defined as follows:

- Speed is the actual rate at which a vehicle is moving at a given time as shown on the speedometer. It is expressed as KPH or MPH.
- Pace is the regulated speed of a convoy or an element as set by a lead vehicle, the pacesetter. It is constantly adjusted to suit road, terrain, and weather conditions. Pace is also expressed as KPH or MPH.
- Rate of march is the average number of kilometers traveled in a specific time period. It includes short periodic halts and short delays, but does not include long halts, such as those for eating meals or for overnight stops. It is expressed in KMIH or MIH. Rate of march is used in movement calculations.

TIME-DISTANCE FACTORS

Time and distance factors (Figure 1-2, page 1-9) are used to perform a wide range of calculations for planning highway movements. They can be used to develop movement tables and to conduct expedient planning and calculating to deconflict movement requests.

Distance Factors

Distance factors are expressed in kilometers or meters. The following terms are used to describe distance factors:

- Length of any column or element of a column– length of roadway which the column occupies. It is measured from the front bumper of the lead vehicle to the rear bumper of the trail vehicle and includes all gaps inside the column.
- Road space – length of a column, plus any space (safety factor), added to the length to prevent conflict with preceding or succeeding traffic.
- Gap – space between vehicles, march units, serials, and columns. Gap is measured from the trail vehicle of one element to the lead vehicle of the following element. The gap between vehicles is normally expressed in meters. The gap between march elements is normally expressed in kilometers.
- Lead – linear spacing between the heads of elements in a convoy or between heads of successive vehicles, march units, serials, or columns.
- Road distance – distance from point to point on a route, normally expressed in kilometers.
- Road clearance distance – distance that the head of a column must travel for the entire column to clear the RP or any point along the route. Road clearance distance equals the column's length or road space plus road distance.

Time Factors

Time is expressed in hours or minutes. The following terms are used to describe time factors:

- Pass time (or time length) – time required for a column or its elements to pass a given point on a route.
- Time space – time required for a column or its elements to pass any given point on a route plus any additional time (safety factor) added to the pass time.

• Time gap – time measured between vehicles, march units, serials, or columns as they pass a given point. It is measured from the trail vehicle of one element to the lead vehicle of the following element.

• Time lead – time measured between individual vehicles or elements of a column, measured from head to head, as they pass a given point.

• Time distance – time required to move from one point to another at a given rate of march. It is the time required for the head of a column or any single vehicle of a column to move from one point to another at a given rate of march.

• Road clearance time – total time required for a column or one of its elements to travel the road distance and clear a point along the route or the RP. Road clearance time equals the column's pass time or time space plus time distance.

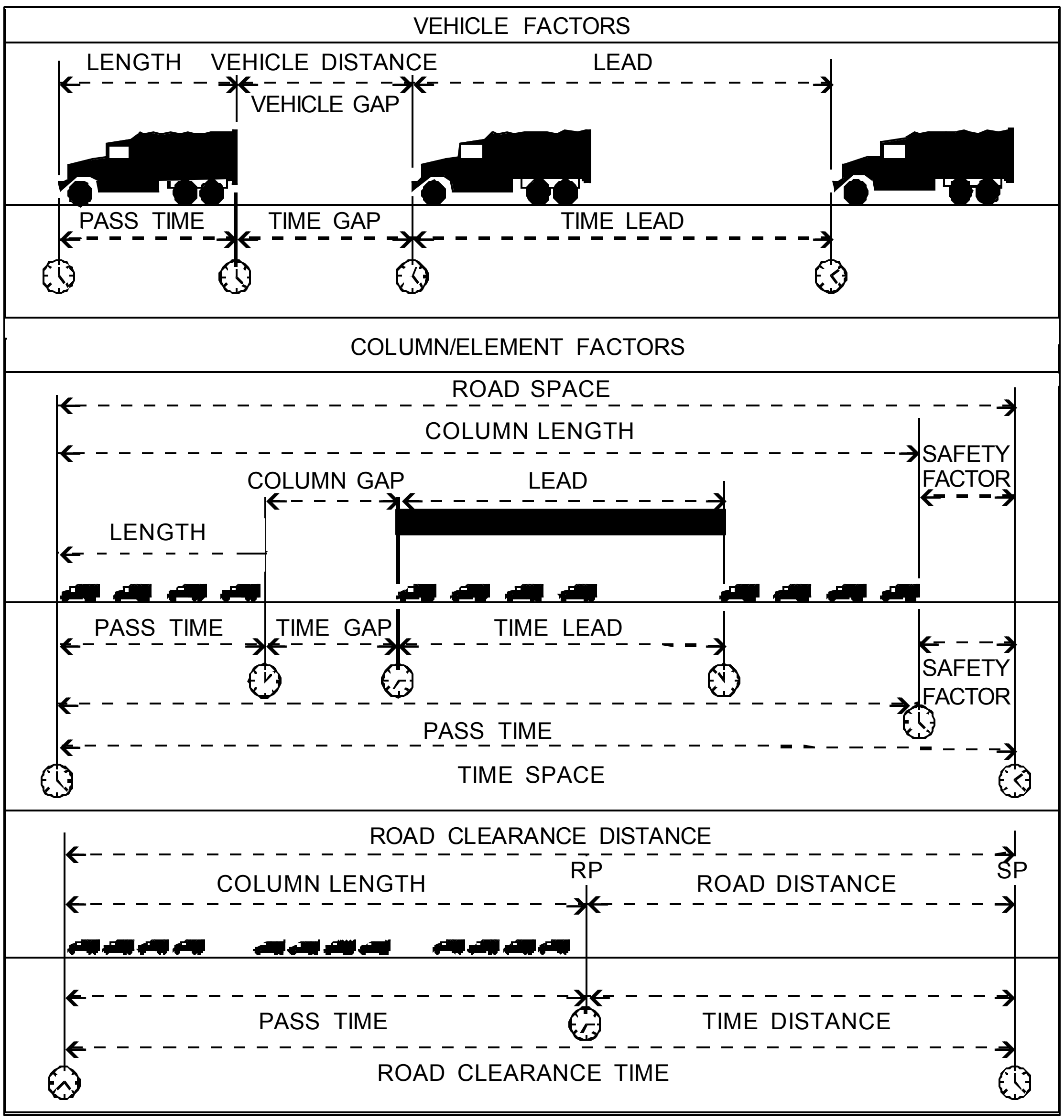


Figure 1-2. Time and distance factors

DISTANCE, RATE, AND TIME CALCULATIONS

Distance, rate, and time factors are used to make scheduling calculations for columns of any size. When two of the three factors are known, the third can be found by using one of the equations shown in Figure 1-3. These factors are determined using the following formulas:

- Distance equals rate multiplied by time. If the rate of march is 40 KMIH and time is 4 hours, the distance is 160 kilometers.

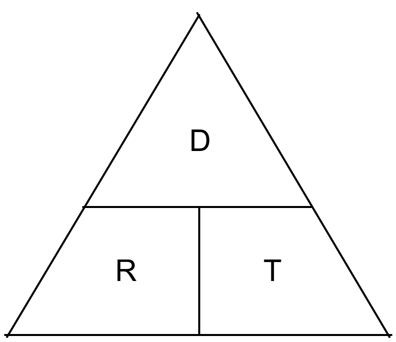
  40 x 4 = 160

- Rate equals distance divided by time. If a convoy travels for 5 hours to complete a 190 kilometer trip, its rate of march is 38 KMIH.

  190 ÷ 5 = 38

- Time equals distance divided by rate. If the distance is 210 kilometers and the rate of march is 42 KMIH, the time is 5 hours.

  210 ÷ 42 = 5



Divide a triangle as shown. To find an unknown factor, cover it. The uncovered portion of the triangle gives you the formula for finding the unknown.

For example

- If distance (D) is unknown, cover it and RT (rate x time) remains.
- If rate (R) is unknown, covering R leaves $\frac{D}{T}$.
- Do the same for time (T), and you find $\frac{D}{R}$ remaining.

Figure 1-3. Finding an unknown factor of distance, rate, or time

ARRIVE AND CLEAR TIME CALCULATIONS

Arrive and clear times are not the same as time factors. The time factors measure a quantity of time or distance. Arrive and clear times represent actual time as displayed on a clock. The arrive time is the time the first vehicle in the column will arrive at an SP, CP, or RP. It is derived from the time distance. The clear time is the time the last vehicle in the column will clear that SP, CP, or RP.

Calculating Arrive Times

The arrive time at the SP is the same as the SP time. Calculate arrive times as follows:

- To calculate the arrive time at the first CP, take the distance from the SP to the first CP, divide by the planned rate of march, and multiply by 60 (minutes). Add this amount of time to the arrive time at the SP to determine the arrive time at the first CP.

Example: Distance from SP to first CP: 10 km
March rate: 50 KMIH

Solution: 10 ÷ 50 = .20 hrs x 60 = 12 min

If the arrive time at the SP was 0800, then the arrive time at the first CP would be 0812.

- To calculate the arrive time at the second CP, take the distance from the first CP to the second CP, divide by the rate of march, and multiply by 60. Add this amount of time to the arrive time at the first CP to determine the arrive time at the second CP.

Example: Distance from first to second CP: 15 km
March rate: 50 KMIH

Solution: 15 ÷ 50 = .30 hrs x 60 = 18 min

If the arrive time at the first CP was 0812, then the arrive time at the second CP would be 0830. Continue this method to calculate the arrive time at succeeding CPs through the RP.

Calculating Clear Times

To calculate the clear times at each CP, planner must determine the pass time. Calculating pass time requires four calculations: density, time gaps, road space, and pass time. These four calculations are determined using the following formulas:

- Density $= \dfrac{1{,}000\ (m)}{\text{vehicle gap} + \text{avg length of vehicle}}$

NOTE: Vehicle gap is expressed in meters, representing the gap between vehicles. Average length of vehicle is expressed in meters, representing the average length of the most common vehicle in the column.

Example: If the vehicle gap is 100 meters and the average vehicle length is 18 meters, then–

$$\text{Density} = \frac{1{,}000}{100 + 18} = \frac{1{,}000}{118} = 8.5 \text{ vehicles per km}$$

- Time gaps = [(number of march units - 1) x march unit time gap] + [(number of serials - 1) x (serial time gap - march unit time gap)].

Example: If a column has two serials with two march units each and the gap between march units is 5 minutes and the gap between serials is 10 minutes, then–

$$\text{Time gaps} = [(4 - 1) \times 5] + [(2 - 1) \times 5] = [3 \times 5] + [1 \times 5] = 15 + 5 = 20 \text{ minutes}$$

$$\text{Road space} = \frac{\text{number of vehicles}}{\text{density}} + \frac{\text{time gaps} \times \text{rate}}{60\ (\text{minutes})}$$

Example: number of vehicles = 87

Density = 8.5 per km
Rate = 50 KMIH
Time gaps = 20

$$\text{Road space} = \frac{87}{8.5} + \frac{20 \times 50}{60} = 10.2 + 16.7 = 26.9 \text{ km}$$

- Pass Time $= \dfrac{\text{road space} \times 60}{\text{rate}}$

Example: Continuation from above.

$$\text{Pass time} = \frac{26.9 \times 60}{50} = \frac{1{,}614}{50} = 32.2 \text{ or } 33 \text{ min}$$

NOTE: Always round pass time up regardless of the decimal value.

In this example, the clear time at the SP is 33 minutes after the first vehicle crosses the SP. If the arrival time at the SP is 0800, the clear time at the SP will be 0833. If the arrival time at the first CP is 0812, the clear time at the first CP will be 0845. Use this same method to calculate the arrive and clear times at succeeding CPs to the RP. This movement can be depicted as follows:

CP	Arrive Time	Clear Time
1	0800	0833
2	0812	0845
3	0830	0903

The pass time will stay the same throughout the route as long as the march rate and density do not change. If the march rate or density changes, then recalculate the pass time to determine the new clear time.

REST HALTS

The march rate compensates for short halts, but does not include scheduled rest halts. Plan scheduled rest halts during the movement planning process. Rest halts are scheduled either at a CP or between CPs.

When planning rest halts, allow time to get vehicles off the road and staged, time to rest, and time to get vehicles back on the road. If you need 10 minutes for a rest halt, then schedule 15 minutes for the halt to ensure time to get vehicles on and off the road.

If a rest halt is scheduled at a CP, the arrive time at the CP does not change. What changes is the clear time at that CP and the arrive and clear times at succeeding CPs. Adjust the clear time by the scheduled halt time. If a rest halt is scheduled between CPs, adjust both the arrive and clear times at the next CP by the scheduled halt time. Continuing with the previous example, if you plan a 15-minute rest halt between CP 2 and CP 3, you must adjust the times as follows:

CP	Arrive Time	Clear Time
1	0800	0833
2	0812	0845
3	0845	0918

Note the 15-minute delay in arriving and clearing CP 3. If you planned the rest halt at CP 2, your adjustments would be as follows:

CP	Arrive Time	Clear Time
1	0800	0833
2	0812	0900
3	0845	0918

Note the 15-minute delay in clearing CP 2, arriving at CP 3, and clearing CP 3.

The pass time will stay the same throughout the route as long as the march rate and density do not change. If the march rate or density changes, you must recalculate the pass time to determine the new clear time. Follow these guidelines to simplify calculations:

- Prepare and use conversion tables for changing US common distances to metric distances, number of vehicles to time length, and distance to time.
- Standardize variables to reduce calculation time. When possible, use standard march rates and density.
- Use automated programs such as MOVEPLAN or DAMMS-R to calculate arrive and clear times.

CHAPTER 2
AIR TRANSPORT

Airlift is a flexible and essential element of the defense transportation system. This chapter contains information on a broad range of military and commercial aircraft used to accomplish the air transport mission.

Section I
ORGANIZATION AND OPERATIONS

ARMY AVIATION

Army aviation units support theater army, corps, and division requirements. They also support unified or specified commands, military assistance advisory groups, mission operating detachments, and separate brigade operations.

Army Aviation Units

The aviation brigade is the Army's primary aviation unit. It is a versatile organization found at division, corps, and EAC. It may include observation, attack, utility, and cargo helicopters and a limited number of fixed-wing C^2 aircraft.

Division. Each division has an aviation brigade designed, configured, and tailored to meet the tactical requirements of that type division. Brigade aircraft move troops, supplies, and equipment. The utility helicopter, either the UH-1 or UH-60, is the brigade's primary asset.

Corps. Each Army corps has an aviation brigade tailored to meet its specific mission requirements. The corps aviation brigade supports the corps scheme of maneuver by planning, coordinating, and executing aviation and combined arms operations. In its CSS role, the brigade moves forces, supplies, and equipment needed to support the battle. The corps commander should routinely allocate sufficient sorties for CSS air movement missions. The corps aviation brigade uses a combination of UH-1, UH-60, and CH-47 helicopters.

EAC. EAC aviation brigades are tailored and configured to meet the needs of the theater. They may be organized with attack, utility, and/or cargo aviation assets. EAC utility and medium helicopters reinforce corps CSS air movement requirements.

Mission

Army logistic aviation units airlift personnel and cargo for CSS and CS operations. Missions assigned to aviation units are usually similar to the mission as stated in the TOE.

Objective

The objective of aviation unit missions is to assist the land force in accomplishing its mission.

Authority

When an aviation company supports a ground unit, the ground unit commander assigns tasks to the aviation commander. To accomplish these tasks, the aviation commander retains the authority to issue orders to elements under his command.

Tables of Organization and Equipment

The TOE of each military unit prescribes its normal mission, organizational structure, and personnel and equipment authorization. Users who need detailed information on a specific aviation unit should use the TOE of that unit. See Appendix A for the TOE of aviation companies that provide logistic support.

AIRLIFT OF MATERIEL

Army air transport was never intended to compete with Air Force airlift. Its purpose is twofold:

- To provide rapid response transport for high-priority personnel, supplies, and equipment to locations inaccessible by other transportation modes.
- To supplement the lift capability of other Army transportation modes.

Areas of Operations

Army air transport is essential to the logistic support of Army operations. It rapidly moves passengers, cargo, and equipment without regard to terrain restrictions. However, there are limitations to the capabilities of airlift.

Communications zone. The aviation brigade provides Army airlift in the COMMZ. Army aircraft move high-priority cargo and personnel to and from Air Force terminals. Also, they rapidly deploy rear area protection forces. Based on the theater movement program, helicopters are positioned where they can best fulfill preplanned requirements. Helicopters are used when speed is essential or the use of other modes is not practical or possible.

Theater of operations. Army airlift is often the link between theater air and ocean terminals and receiving supply activities, receiving units, or TTPs. This air movement may be preplanned or immediate. For example, the MCA may task the COMMZ aviation brigade to transport high-priority cargo daily from theater air terminals forward to the supply activity. Either the supply activity issues the cargo, or the MCA pulls the preplanned commitment and issues a higher priority immediate commitment.

There are both advantages and limitations to Army air transport in a theater of operations. Advantages include flexibility, speed, internal or external transport of cargo or equipment, and immunity to surface or terrain conditions. Limitations include vulnerability to enemy air action; vulnerability to air defense weapons and other ground fire; susceptibility to adverse weather; inherent decrease in lift capability as air density decreases due to changes in altitude, temperature, or humidity; higher maintenance per operating hour than other modes; and dependence on logistical support.

Corps. The MC battalion manages Army air transport originating in the corps, controlling and directing which logistic support missions the helicopters will fly. Its CSS helicopters come from the corps aviation brigade. MC battalion management of all corps logistic transportation assets is essential to ensure the best mode is used to accomplish the mission.

Helicopters are a highly mobile and responsive means for moving equipment and supplies. Air transport units move troops, ammunition, repair parts, POL, engineer material, artillery, special weapons, disabled aircraft and vehicles, and other large or heavy items. Helicopters also augment surface transportation to meet increased transportation demands in surge operations, overcome terrain obstacles, and meet time-sensitive requirements.

Single-ship, independent operations generally characterize helicopter logistic missions. Helicopters do not routinely operate forward of the brigade support area. However, the trend to position more units forward and to dedicate aircraft for weapons system resupply requires the increased forward employment of helicopters. Aircraft may operate as close as 5 to 7 kilometers from the forward edge of the battle area.

They may also operate beyond the FLOT to support deep operations. Logistic support of the covering force justifies added cargo helicopter commitments in the forward area to support maneuver units. Both external loads at high altitudes and internal loads are used, coupled with nap-of-the-earth flying. Division utility helicopters provide most of the intradivision air transport support.

Preplanned and Immediate Air Movement Requests

Requirements for air movement operations are characterized as either preplanned or immediate. See FM 55-10 for more information on coordinating preplanned and immediate air movements.

Preplanned requests. Preplanned airlift involves matching movement requirements against airlift capability. Movement planners determine in advance that air is the best or most effective mode based on the urgency of the requirement and characteristics of the personnel, supplies, or equipment to be moved. Preplanned air movements are generally (but not necessarily) carried out over established routes.

Immediate requests. Immediate airlift missions result from unanticipated, urgent, or priority movement requirements. Movement planners must quickly determine if air is the best and most effective mode based on the urgency of the requirement and characteristics of the personnel, supplies, or equipment to be moved. Examples include:

- Unplanned requirements for resupply or repositioning of existing supplies.
- Emergency movement of personnel and equipment.
- Assistance to aeromedical air ambulance units.
- Prevention of congestion at an air or ocean terminal.

Request procedures must be responsive and flexible to support rapidly changing situations. Immediate airlift may or may not be carried out over the established air lines of communications.

Employment Considerations

Optimum use of airlift is attained by using Air Force transport aircraft to move materiel from a COMMZ depot directly to the user. However, in a tactical situation this is often impracticable. There is generally a point at which wholesale airlift is terminated and Army aviation elements undertake retail deliveries to the user.

Wholesale airlift. Certain factors must be considered when determining the point at which to terminate wholesale airlift. These include the following:

- Airfields – suitable airfields must be available at point where materiel is to be airlanded by Air Force transport aircraft.
- Enemy action – The enemy may be capable of limiting or denying the use of forward areas for airlanding by transport aircraft.
- Receiving unit capability – combat units in forward areas have a limited capability to receive, store, protect, and redistribute materiel airlanded in wholesale lots by transport aircraft.
- User requirements – the user may be a unit of company size or smaller that requires resupply in retail quantities only.

Efficiency. The efficient use of Army aviation is based on the factors of economy of use and ready availability. Aircraft should not be used to transport cargo when surface transportation is equally effective. Since there are seldom enough aviation assets to satisfy all requirements, most aviation support is allocated on a priority basis. The ability to respond rapidly increases the value of airlift to commanders. While aircraft are capable of supporting units located throughout a wide area, ready availability is enhanced when aviation units are located close to supported units. The intelligent scheduling of operational aircraft and programming of required maintenance further enhances ready availability.

Operational Considerations

Several elements bear directly on the conduct of airlift operations. These influence operational efficiency as well as the safety of personnel and equipment.

Air density. Unlike surface transportation where the payload of a particular vehicle is relatively fixed, aircraft payloads are affected by air density. Denser air gives greater lift to an aircraft's wing or rotor blade, increasing the weight-lifting performance of the aircraft. Temperature, altitude, and humidity all affect air density.

Temperature. An increase in temperature causes a decrease in air density. The amount of air that occupies 1 cubic inch at low temperatures will expand and occupy 2 or 3 cubic inches as the temperature rises. The payload of a particular aircraft can change, depending on the time of day a flight is scheduled. In general, early morning temperatures favor operations, and warmer noonday temperatures cause a decrease in the efficiency of the aircraft.

Altitude. An increase in altitude causes a decrease in air density. This is especially important when conducting operations from areas high above sea level. During these times it is necessary either to decrease the aircraft weight or to increase the length of takeoff and the landing strip.

Humidity. An increase in humidity causes a decrease in air density. Air always contains some moisture (water vapor), but the amount varies from almost 0 to 100 percent. We refer to this water vapor as humidity. As humidity increases, water particles displace the air, causing a decrease in air density and reducing the performance efficiency of the aircraft.

Distance. The distance to be flown is especially important because the allowable load is computed after the amount of fuel, plus reserve, is determined. When the maximum payload is desired, aircraft must carry less fuel with a relative reduction in distance flown. The payload must be reduced when the maximum distance is desired.

Weather. Weather impacts Army aviation operations. While low ceilings and limited visibility restrict operations, such conditions also shield the aircraft from enemy observation. However, adverse weather generally reduces efficiency of Army airlift operations. Although Army transport aircraft can operate under instrument flight conditions, commanders should establish weather minimums to preclude scheduling flights that jeopardize the safety of aircraft and personnel. The following factors should be weighed when establishing weather minimums:

- Pilot experience.
- Type of aircraft.
- Urgency of mission.
- Navigational aids available.
- Flight route terrain.
- Time of operation.

Enemy situation. The location and capabilities of enemy forces must be considered before finalizing flight routes for Army air transport operations. Avoid areas where suspected enemy antiaircraft weapons or known enemy ground fire exist. Prepare prearranged evasive-action flight plans for aviation units in case enemy aircraft are encountered.

Terrain. Terrain features should be considered with regard to their possible effects on each operation. Terrain influences the following:

- Location of takeoff and landing sites.
- Flight routes.
- Identification of prominent landmarks for navigational purposes.
- Location of navigational aids.
- Location of emergency landing sites.

Flight routes. Combat operations generate many demands for the use of airspace. Employment of US military aircraft, artillery, drones, and missiles must be coordinated to ensure adequate safety, proper identification, and operational efficiency. Army aviation unity ensures that flight routes are properly coordinated and approved by the appropriate air traffic control facility before beginning CSS or CS operations.

Communications. CSS and CS airlift operations require that adequate communications be established before a mission. Voice communication is necessary among Army air transport and command units, supported organizations, inflight aircraft, and takeoff and landing sites.

Support Requirements

Primary support requirements are the availability of POL, ammunition, and aircraft maintenance support.

Petroleum, oils, and lubricants. Aircraft use large quantities of fuel, and POL requires special handling. For these reasons, refueling facilities should be readily available.

Ammunition. Because the ammunition used in Army aircraft may be expended rapidly, resupply facilities must be located near the area of operations. This avoids the time penalty involved in resupply.

Aircraft maintenance. The sustained performance of aircraft operations depends on efficient aircraft maintenance. Maintenance of aircraft begins with AVUM and extends through AVIM to depot maintenance. The continuing availability of aircraft requires close coordination among the aviation unit commander, the ground combat commander, and the supporting maintenance unit commander. Proper scheduling of aircraft for maintenance is mandatory to prevent excessive downtime.

Section II
LANDING SITE SELECTION AND PREPARATION

SITE SELECTION

The selection of a PZ or LZ is extremely important. Logistical and tactical considerations must be analyzed to ensure that the PZ or LZ is correctly placed to support the mission. The area must be accessible to the aircraft that will use the site. The supported/receiving unit commander – in coordination with the aviation unit liaison officer, if available – will select and prepare the PZ. The aviation unit liaison officer makes the final decision concerning minimum landing requirements.

Dimensions

The size of the landing site depends on the number and size of the landing points within it and the dispersion required between the landing points as the tactical situation dictates (Figure 2-1, page 2-6). The minimum size of a landing point for each size helicopter is shown in Table 2-1, page 2-6. Many factors, including the following, determine the size of the landing points:

- Helicopter type.
- Unit proficiency.
- Nature of the load.
- Climatic conditions.
- Day or night operations.

If this data is not available through the aviation unit, a size 5 landing point should be prepared. The minimum recommended distance between landing points within the LZ, where no consideration is given to dispersion, is the same as the minimum diameter of that size helicopter's minimum diameter; only measure from the center of one landing point to the center of the other (Figure 2-2, page 2-7).

Surface

The surface of the center of the landing point must be level and sufficiently firm to allow a fully loaded vehicle (1/4-ton truck for size 1 or 2 helicopters and a 3- to 5-ton truck for size 3 to 5 helicopters) to stop and start without sinking. Clear the entire landing point of loose material, piles of dust, or sand that could be blown up by the aircraft's rotor blades. Stabilize landing points with a sandy or dusty surface. Clear away all trees, brush, stumps, or other obstacles that could cause damage to the main or tail rotor blades or to the underside of the aircraft. Pack or remove snow to reveal obstacles and to reduce the amount of loose snow blown over the area. In a snow-covered LZ, a marker panel is essential to provide a visual reference for the pilot's depth perception and to reduce the effect of whiteout.

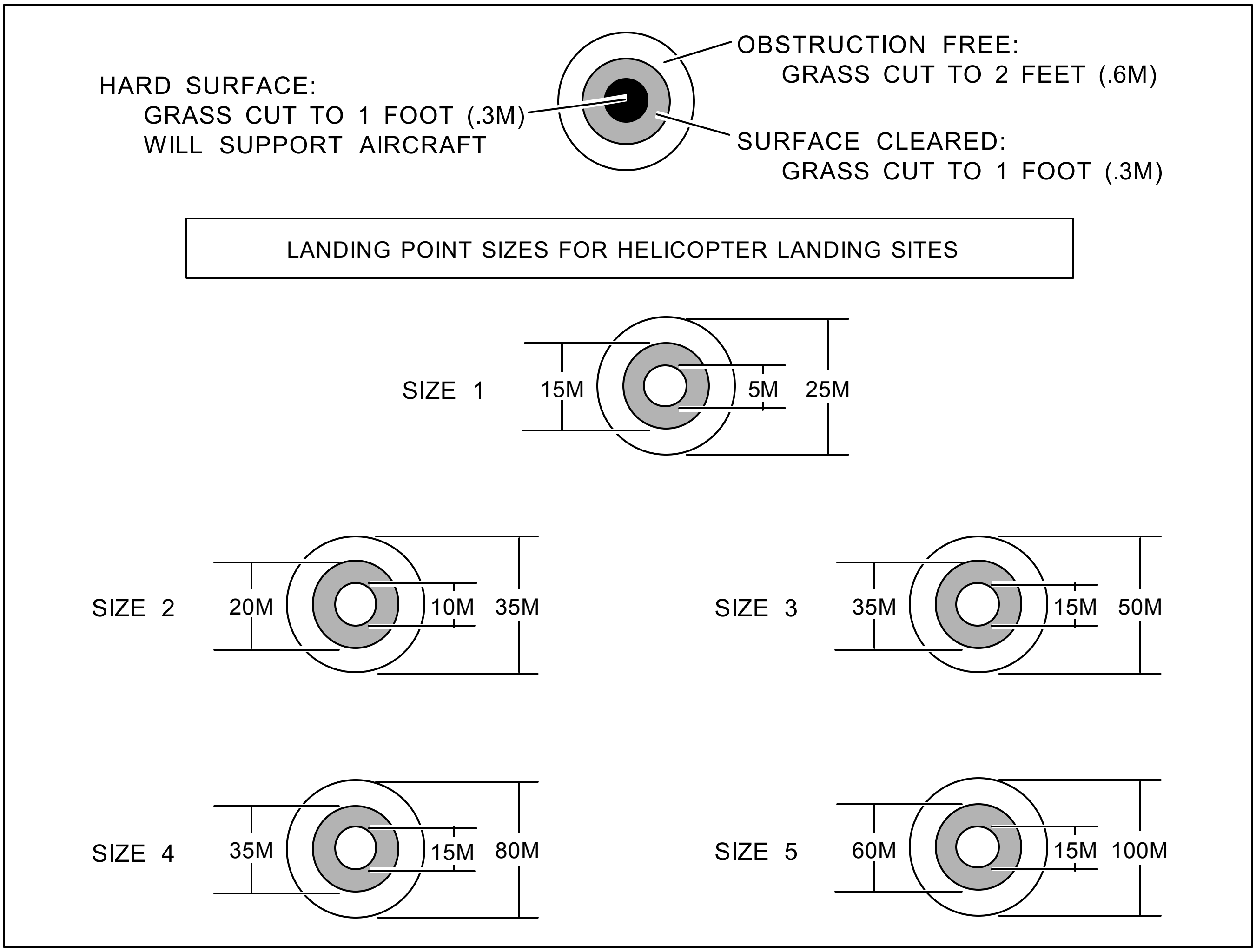


Figure 2-1. Helicopter landing sites

Table 2-1. Size helicopter for landing point

HELICOPTER SIZE	MINIMUM DIAMETER OF LANDING POINT	TYPE HELICOPTER
1	80 feet (25 meters)	OH-6, OH-58
2	125 feet (35 meters)	UH-1
3	160 feet (50 meters)	UH-60
4	264 feet (80 meters)	CH-47, CH-53, CH-54
5	328 feet (100 meters)	To be developed

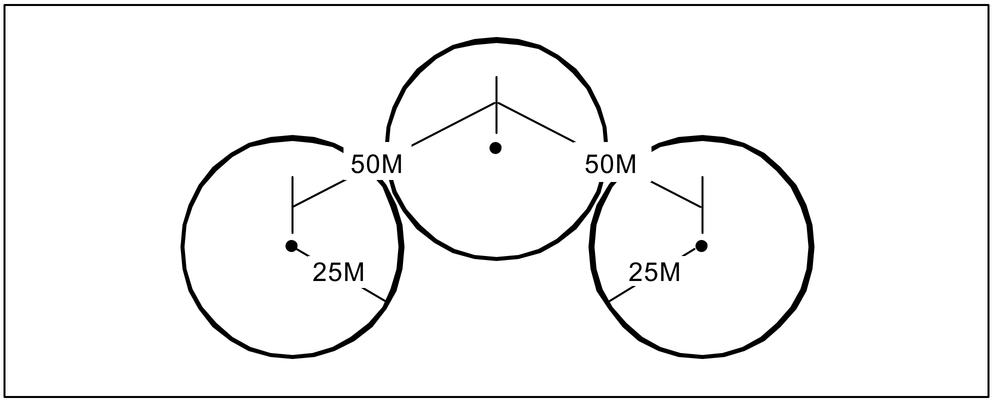


Figure 2-2. Size 3 aircraft landing zone for V-formation

Slope

Ideally, the ground at the landing point should be level. Where a slope is present, it should be uniform. If the helicopter is to land during a daylight approach, the slope should not exceed 7 degrees (1 in 8). A greater slope may be acceptable for hover operations. During a night approach, a reverse slope as viewed from the approach path is generally not acceptable. A forward and/or lateral slope should not exceed 3 degrees (1 in 19). If these criteria cannot be met, use of the landing point must be confirmed by the aviation unit (Figure 2-3, page 2-8).

Approaches

Ideally, there should be an obstruction-free approach and exit path into the wind. Approaches that do not meet the following minimum requirements may be acceptable depending on the nature of the operation. However, when these criteria cannot be met the aviation unit must be consulted.

Daytime. Within the selected approach and exit paths, the normal maximum obstruction angle to obstacles during daylight hours should not exceed 6 degrees, as measured from the center of the landing point to a distance of 1,640 feet (500 meters). The maximum obstacle height at the 1,640-foot mark is 171 feet (52 meters) (Figure 2-4, page 2-9).

Nighttime. The selected approach and exit paths should contain a sector of not less than 16 degrees in azimuth measured from the center of the landing point. The width of the approach and exit path should not be less than the width of the area in the landing point cleared to 2 feet (.6 meters) in height. Less than 164 feet (50 meters) is not acceptable; more than 328 feet (100 meters) is not necessary. Within the selected approach and exit path, the maximum obstruction angle should not exceed 4 degrees as measured from the center of the landing point to a distance of 9,843 feet (3,000 meters). The maximum obstacle height at the 9,843-foot mark is 689 feet (210 meters) (Figure 2-5, page 2-9).

Density Altitude

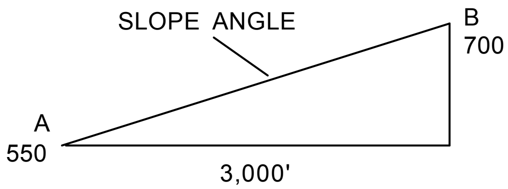
Density altitude is determined by altitude, temperature, and humidity. As density altitude increases, the size of the LZ must be increased proportionately. Hot and humid conditions at a landing site decrease the lift capabilities of helicopters using the site. A large area and better approach and/or departure routes are required more for fully loaded helicopters than for empty or lightly loaded ones. This is because most helicopters cannot climb or descend vertically when fully loaded.

Concealment

A PZ/LZ near the FLOT should be masked whenever possible. Base the selection of approach and exit routes on the availability of good masking features.

GROUND SLOPE EXPRESSED IN DEGREES

The approximate slope angle may be calculated by multiplying the gradient by 57.3. This method is reasonably accurate for slope angles under 20°.



VD B A 150

HD 3,000

$$\text{DEGREE OF SLOPE} = \frac{150 \times 57.3}{3,000}$$

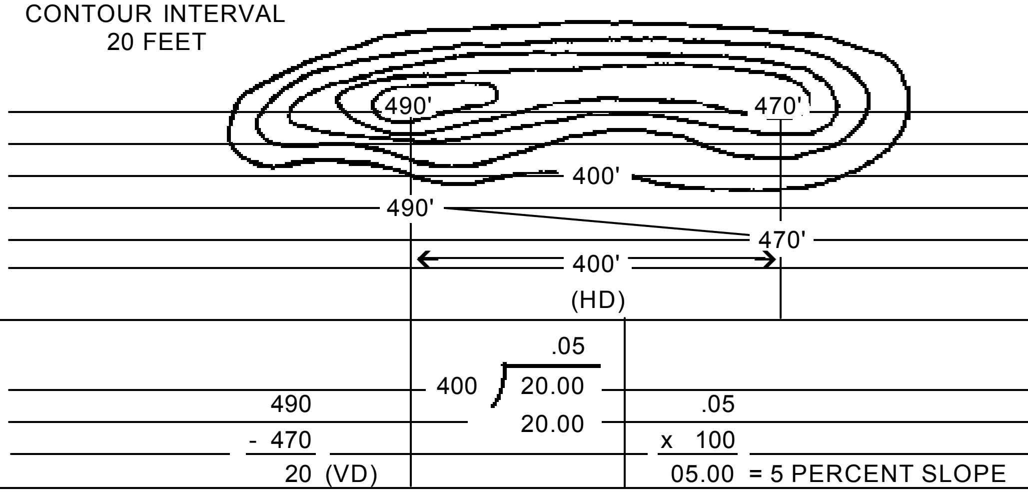
$$\frac{8,595}{3,000} = \text{Approximately } 3^\circ \text{ of Slope}$$

GROUND SLOPE EXPRESSED AS PERCENTAGE

To determine the percent of ground slope, divide the vertical distance (VD) by the horizontal distance (HD) and multiply by 100.

$$\text{PERCENT SLOPE} = \frac{VD}{HD} \times 100$$

Vertical distance is the difference in field elevation between the two ends of the landing site. Always round number up to the next whole number.



SLOPE LANDING RULES

Utility and observation aircraft will not be landed on slopes exceeding 7 degrees. Large utility and cargo aircraft will be given an advisory if ground slope is between 7 to 15 degrees.

Figure 2-3. Determining ground slope

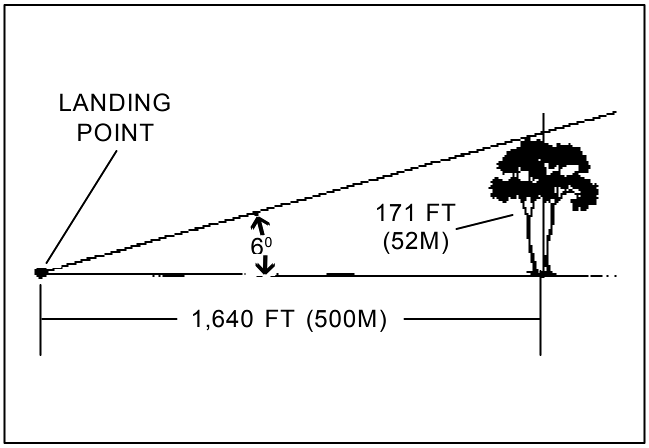


Figure 2-4. Maximum angle of approach (daytime)

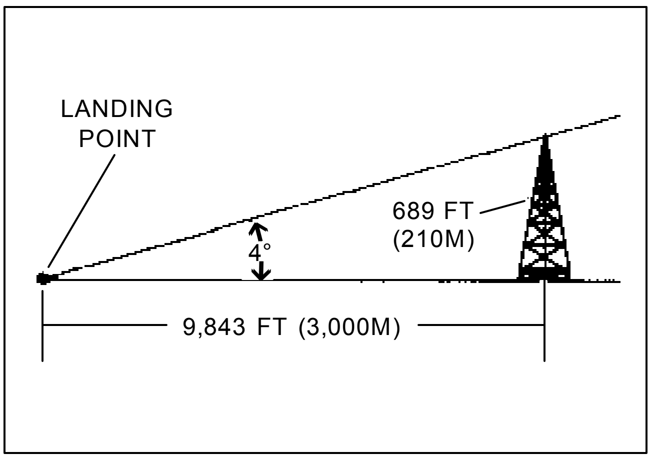


Figure 2-5. Maximum angle of approach (nighttime)

SITE PREPARATION

Once the site has been selected, the ground crew must prepare the PZ/LZ for safe, efficient operations.

Receiving Flight Formations

In large tactical relocations or resupply missions, helicopters will usually fly in formation. The PZ/LZ and the ground crew must be prepared to receive them. Helicopters should land in the same formation in which they are flying. However, planned formations may require modification for helicopters to land in restrictive areas. If a modification in flight formation is required for landing, use the change requiring the least shift of helicopters and notify the flight leader as soon as radio contact is made (Figure 2-6, page 2-10).

Many times, size 4 helicopters will not fly in standard flight formations and will be received one or two at a time. In such cases, each aircraft approaches and hovers at the Y and then is guided to its cargo pickup point by the signalman.

Marking the Landing Site

During daylight operations, the landing site is marked with colored smoke. It is also marked by the ground guide who holds both arms straight up over his head or holds a folded VS-17 signal panel, chest-high. Although the landing site can be marked with signal panels, these are seldom used because the helicopter's rotor wash may tear the panels from the ground and create a hazard.

CAUTION

When using colored smoke to mark the PZ/LZ, be sure the canister is far enough away from the landing point so the rotor wash does not pick up the smoke and obstruct pilot vision.

During night operations, amber beacon lights mark the landing point for the lead aircraft. The single point landing site – or the landing point for the lead aircraft, if the aircraft are in formation – is marked with either an inverted Y or T (Figure 2-7, page 2-10). The aircraft will touch down or hover on the midpoint of the legs of the Y and to the left of the stem if the T is used. The landing points for the other aircraft in the formation are also marked with lights. For size 1 through size 3 helicopters, a signal light is used to mark the landing point; size 4 and 5 helicopters have two lights spaced 10 meters apart to mark the landing point. The aircraft lands to the left of the lights. Whenever the size of the LZ/PZ permits, landing points should be increased to the next larger size. This provides an extra margin of safety for night operations.

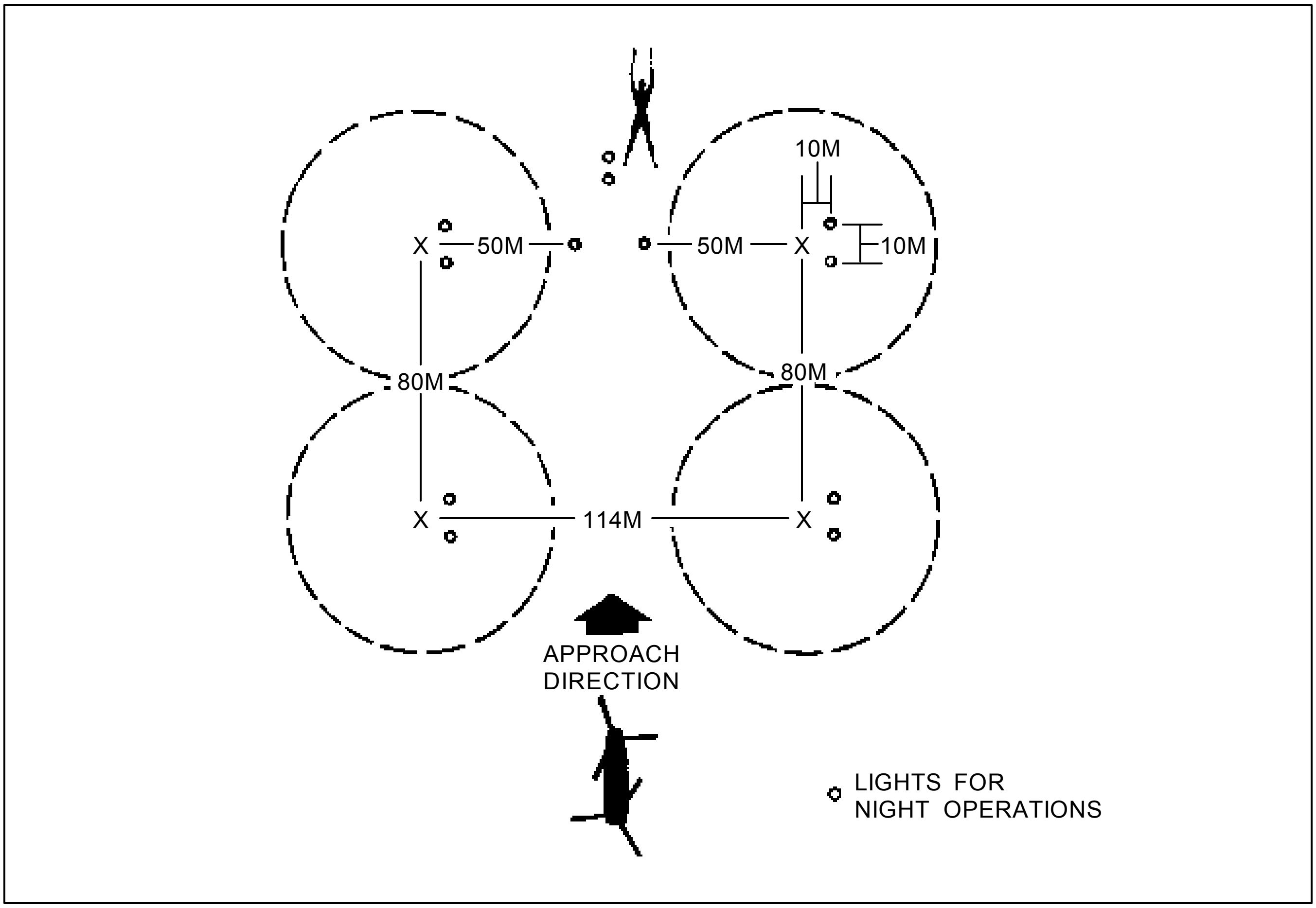


Figure 2-6. Landing zone/pickup zone landing formation for size 4 helicopters

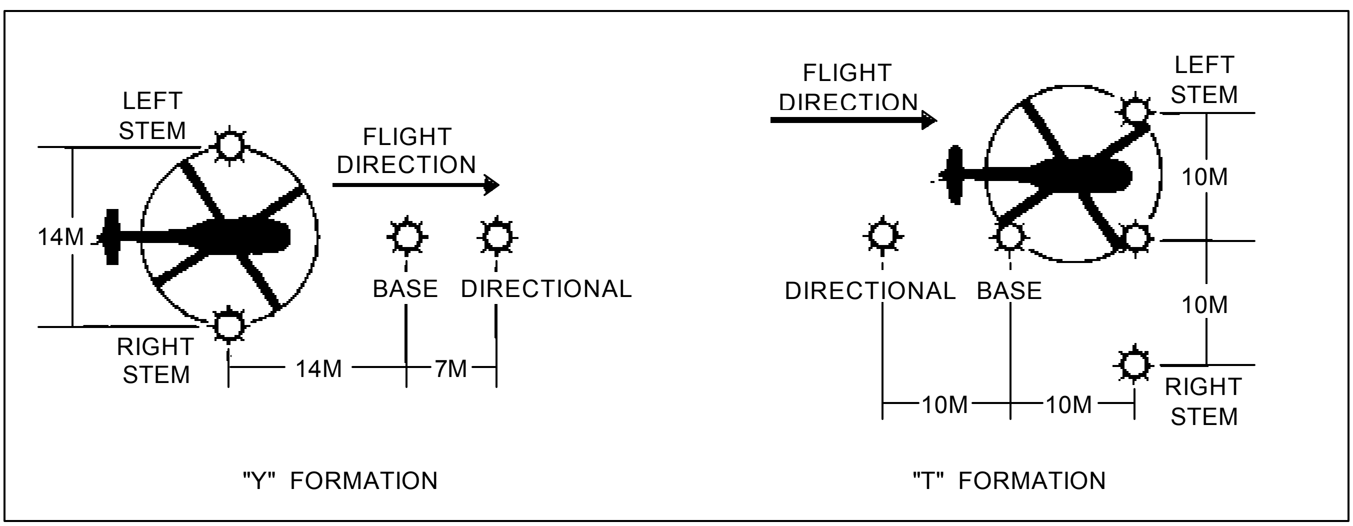


Figure 2-7. The Y- and T-formations for single-point formation landing sites

Marking Obstacles

During daylight operations, obstacles that may be difficult to detect or impossible to remove – such as wires, holes, stumps, and rocks – are marked with red panels or by other easily identifiable means. Devices used to mark obstacles must be colored red. During night operations, red lights are used to mark all obstacles that cannot be easily identified. In most combat situations, the need for security prohibits the use of red lights to mark the tops of trees on the approach and departure ends of the LZ. In training or in a rear area landing site, however, red lights should be used whenever possible. If obstacles or hazards cannot be marked, fully advise aviators of existing conditions by radio.

Section III
CARGO-CARRYING AIRCRAFT

EXTERNAL TRANSPORT HELICOPTERS

Helicopter transport can overcome many obstacles that hinder other modes from completing the mission. However, all aspects – advantages, disadvantages, and unit responsibilities and functions – must be considered when planning air cargo movements.

Advantages

External transport helicopters rapidly move heavy, outsize, or "needed now" items directly to their destinations. Damaged or congested highways, destroyed bridges, and most en route terrain obstacles have little impact on cargo transport. The helicopter may use different flight routes to provide a diversion and maintain security of the unit on the ground.

Also, cargo may be rapidly moved into or taken out of an area, which helps the ground unit obtain items of equipment when and where they are needed. On a rapidly changing battlefield, the helicopter can place fire power where it is needed and then relocate it. A PZ/LZ can be relocated to avoid detection and thus aid in ground security.

Disadvantages

The disadvantages to using external transport helicopters appear when the size, weight, and flight characteristics of the cargo fall outside of the aircraft design limits. When suspended beneath the aircraft, cargo that is too light or too bulky will not ride properly. If the cargo is too heavy, the aircraft cannot lift it.

Generally, restrictions that apply to helicopters also apply to sling-load operations or routine training flights. The following factors should be considered to ensure that aircraft are used wisely:

- Limited aviation assets.
- Maintenance downtime.
- Mission priority.

Weather conditions and the PZ/LZ terrain can present natural obstacles to the use of aircraft. These factors are especially critical during external sling-load missions. When operations are planned during hours of darkness or under reduced visibility, the size of the PZ/LZ must be increased to give the pilot more room to maneuver.

Responsibilities

There are usually three elements involved in a sling-load mission: the supported unit (requests the mission), the aviation unit (provides the aircraft), and the receiving unit (receives the cargo). Sometimes, such as during a unit relocation, the supported and receiving units are the same. The responsibilities and functions of each unit are discussed below.

Supported unit. The supported unit selects, prepares, and controls the PZ (pathfinders can be of great assistance in this area) and requisitions all equipment needed for sling-load operations. Needed equipment includes slings, A-22 cargo bags, cargo nets, and containers. Other supported unit responsibilities include:

- Storing, inspecting, and maintaining all sling-load equipment.
- Providing a sufficient number of trained ground crews for rigging and inspecting all the loads, guiding the helicopters, hooking up the loads, and clearing the aircraft for departure. (While the supported unit is responsible for ensuring that the load is properly rigged, the pilot has the right to refuse the load if he notices a rigging error while approaching the load or if the load does not ride properly when first picked up to a hover.)
- Securing and protecting sensitive items of supply and equipment.
- Providing load derigging and disposition instructions to the receiving unit.
- Providing disposition instructions to the receiving and aviation units for the slings, A-22 cargo bags, cargo nets, and containers.

Aviation unit. The aviation unit establishes coordination with the supported and receiving units and appoints a liaison officer. The liaison officer should be thoroughly familiar with the capabilities and limitations of the assigned aircraft. Aviation unit responsibilities also include:

- Advising the supported unit on the size and weight limitations of the loads that may be rigged.
- Advising the supported and receiving units on the suitability of the selected PZ/LZ.
- Providing assistance for the recovery and return to the PZ of the slings, A-22 cargo bags, cargo nets, and containers, as required by the supported unit. (The supported unit is still responsible for packaging and providing disposition instructions to the aviation unit.)
- Arranging for the aircraft to be at the PZ/LZ on schedule.
- Establishing safety procedures that ensure uniformity and understanding of the duties and responsibilities between the ground and flight crews. For example, determining the direction of the ground crew's departure (from beneath the helicopter) after hookup. If the ground crew moves from the aircraft in the same direction as the aircraft, injury could result. Each PZ has a different shape and obstacle. In an emergency, the pilot must know in which direction to set down the aircraft to avoid hitting the ground crew.

Receiving unit. The receiving unit selects, prepares, and controls the LZ. It also provides trained ground crews to guide in the aircraft and derig the load. Other receiving unit responsibilities include:

- Coordinating with the supported (sending) unit for the control and return of the slings, A-22 cargo bags, and other items that belong to the supported unit, and returning them as soon as possible.
- Preparing, coordinating, and inspecting back loads – such as slings, A-22 cargo bags, and so forth – and having them ready for hookup or loading.

Methods

There are three approved methods of external air transport. These methods employ slings, cargo nets, or cargo bags.

Slings. Figure 2-8 shows the 10,000- and 25,000-pound capacity slings used in external air transport operations.

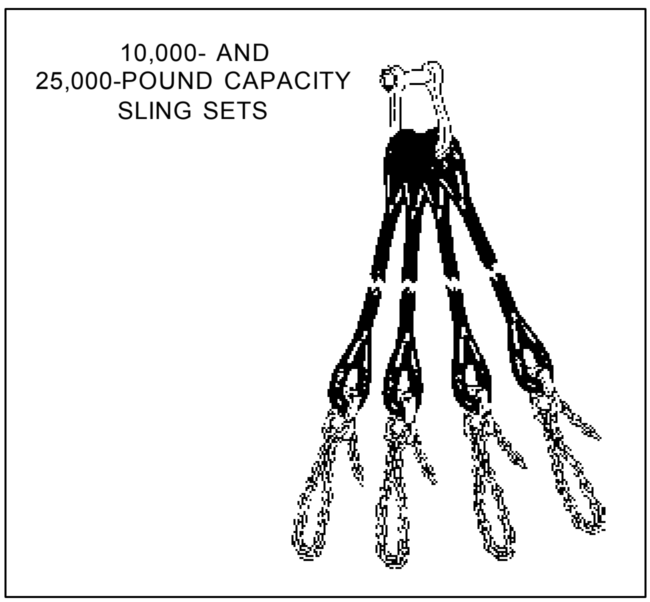


Figure 2-8. External air transport slings

Cargo nets. Figure 2-9 shows the 5,000- and 10,000-pound capacity cargo nets used in external air transport operations.

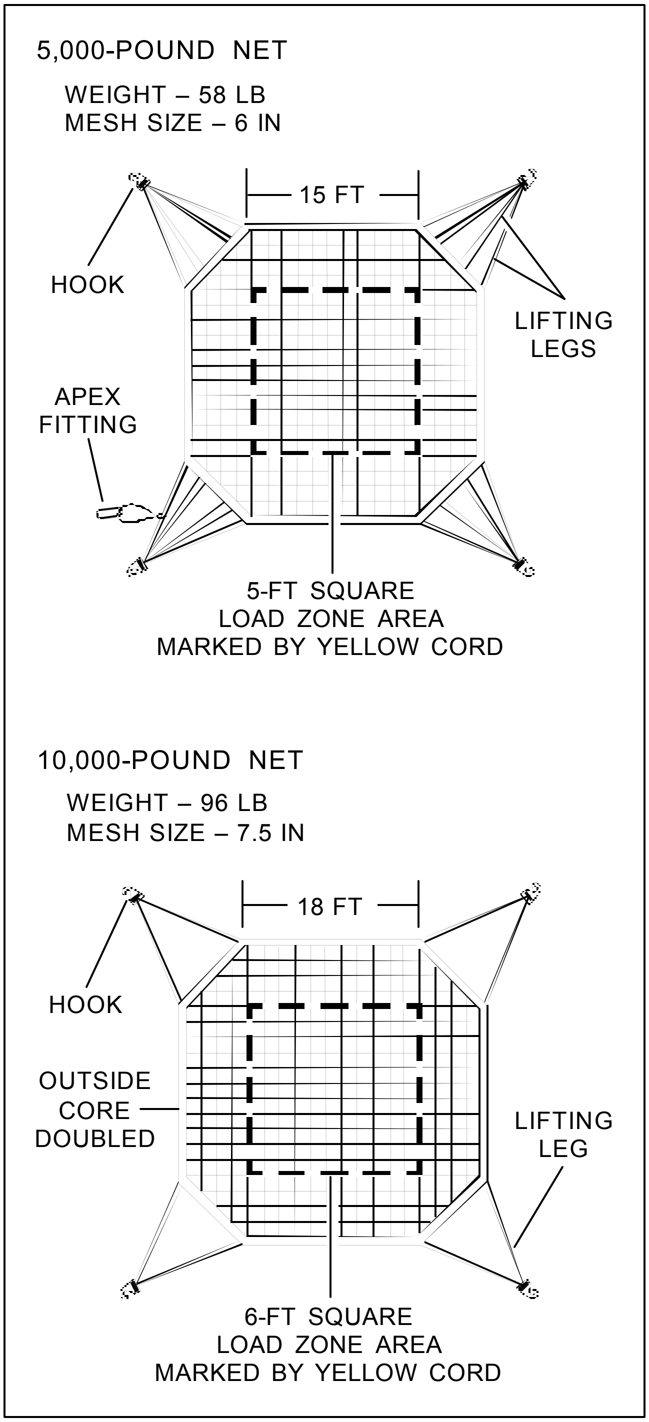


Figure 2-9. Cargo nets

Cargo bag. The A-22 cargo bag (Figure 2-10) is an adjustable cotton duck cloth and webbing container. It has a sling assembly, cover, and four suspension webs. This external carrying device can transport up to 2,200 pounds, including any standard palletized load, loose cargo, or oil drums. It can be rigged with or without the cover.

Personnel

The number of personnel in a ground crew depends on the situation, type of cargo, and size of the pickup zones. Generally, however, three people make up the ground crew: the signalman, the hookup man, and the static wand man. The unit commander decides how many crews to train. The commander also provides local security for the operation. (This task is not a responsibility of the ground crew.)

More than three people may be needed to prepare large items of equipment for sling-loading. For example, bridge sections or towers may need as many as eight people to manhandle them into place. Although each member of the crew has specific duties during the operation, each person should be cross-trained to perform all duties.

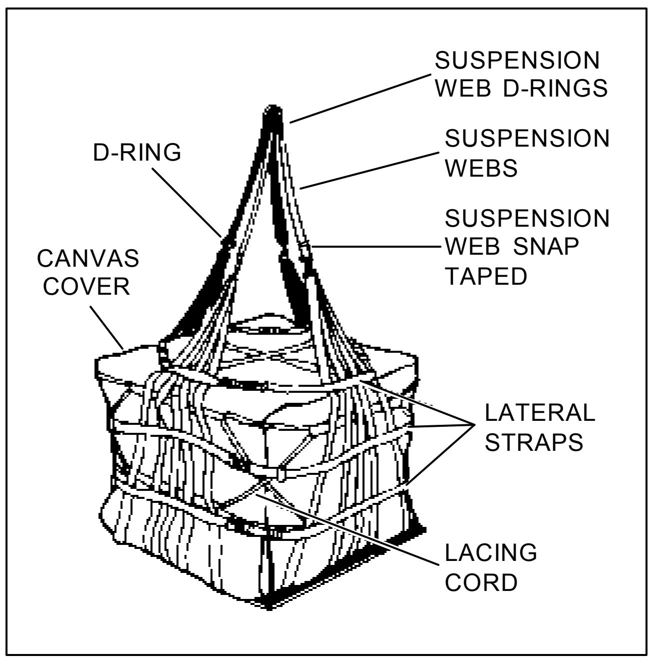


Figure 2-10. A-22 cargo bag

Equipment

If they are to conduct safe and efficient sling-load operations, ground crews must have the right equipment in sufficient supply.

Rigging and hookup. Besides weapons, radios, and operational equipment, each ground crew needs a separate and complete issue of rigging and hookup equipment. This is because there may be several PZs or LZs, and they may be spread over a large area. See FM 55-450-3, -4 and -5 for the proper method of rigging loads for external air transport.

Protective. Ground crews involved in helicopter operations are exposed to the hazards of noise and rotor downwash caused by the helicopter. Therefore, ground crew members must wear protective equipment while they perform their duties.

Pickup zone/landing zone. At a minimum, the equipment needed to operate the PZ/LZ includes helmets, goggles (or protective masks), snap-ring pliers, ear plugs, gloves, smoke grenades, a T33 tool kit (pliers and pocket knife), and static electricity discharge probe.

Static electricity discharge. In flight, a helicopter generates and stores a charge of static electricity. When the helicopter lands, this charge is grounded out. While the helicopter is flying, the charge remains stored unless a path is provided for it to be channeled into the earth. A ground crew member provides this path by touching the helicopter cargo hook when it is positioned over a cargo hookup point. This charge may not cause an electrical burn. However, if the crew member is on unsure footing, it can cause a muscular reaction that may result in injury from a fall. An individual shocked by the electricity may also suffer delayed discomfort from muscular cramps or spasms.

To prevent a ground crew member from being shocked, a discharge probe is used to ground the cargo hook. This probe channels the electricity from the helicopter directly into the ground. The probe consists of an insulated plastic tube with a metal hook on one end and a wire attached to a ground rod on the other end (Figure 2-11). Because contact will cause severe shock, the entire length of wire must be insulated. In use, the ground rod is driven into the earth and the contact rod is held by a ground crew member. As the helicopter hovers over the load, the static wand man holds the contact rod against the cargo hook load beam, thus grounding out the stored electrical charge. Meanwhile, the hookup man places the clevis (apex) on the cargo hook.

WARNING

Contact between the discharge probe and the cargo hook must be maintained until the clevis (apex) is placed on the cargo hook. If contact between the probe and the cargo hook is not maintained, the ground crew may receive a serious shock. This does not mean the ground crew should rig a spring clip to hook directly to the aircraft. If contact between the probe and cargo hook is broken, then contact must again be made before touching the cargo hook.

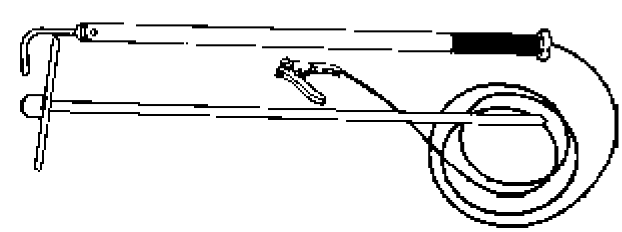


Figure 2-11. Static electricity discharge probe

INTERNAL TRANSPORT HELICOPTERS

Like external air transport, internal transport helicopters offer a viable, expedient alternative to surface modes. In a crisis, helicopter transport may be the only solution.

Advantages

Helicopters rapidly and directly move personnel and materiel to their destination. Damaged or congested highways, destroyed bridges, and most en route terrain obstacles have little affect on cargo transport. The helicopter may use different flight routes to provide a diversion and to maintain security of the unit on the ground. Helicopters move cargo rapidly into or out of an area, a distinct advantage for ground units that get equipment when and where they need it. Helicopters also move combat troops and weapons to locations where they are needed and then quickly relocate them in a rapidly changing battlefield situation. An LZ can easily be moved to avoid detection and ensure security.

Disadvantages

When the size and weight of the cargo exceeds the design of the aircraft, the disadvantages of transporting cargo internally by helicopter become clear. Restrictions that apply to helicopters in general also apply here, whether for internal load operations or a routine training flight. Also, aviation assets are limited; maintenance downtime and priority of missions must be considered to ensure that aircraft are used wisely. Bad weather may affect operations and the LZ terrain present natural obstacles. As is the case with external sling-load missions, these factors may severely restrict internal load missions.

Responsibilities

There are three separate elements involved in an internal load mission: the supported unit (requests the mission), the aviation unit (provides the aircraft), and the receiving unit (receives the cargo).

Supported unit. The supported unit selects and controls the pickup zone (pathfinders can be a great help in both tasks) and ensures that advanced coordination is conducted within the aviation unit. Other responsibilities of the supported unit include the following:

- Before equipment is prepared, ensuring the careful review of all loading, tie-down, and unloading procedures; tie-down diagrams; and tie-down data tables.
- Preparing supplies and/or equipment for air transport with technical supervision and assistance from the appropriate field support units.
- Ensuring that cargo loaded on vehicles is restrained in the vehicle and that all loose equipment in the vehicle is secured.
- Loading the vehicle into the helicopter, tying it down, and unloading it from the helicopter, once the helicopter commander, flight engineer, or crew chief gives approval.
- Ensuring that loads are properly prepared and do not exceed weight or size limitations imposed by the transporting helicopter.
- Providing all personnel involved in or near the loading operations with appropriate safety equipment.
- Policing the pickup zone.

Aviation unit. The aviation unit establishes coordination with the supported and receiving units and appoints a liaison officer. The liaison officer should be thoroughly familiar with the capabilities and limitations of the assigned aircraft. Other aviation unit responsibilities include:

- Advising the supported unit on size and weight limitations of the loads that may be lifted.
- Advising the supported and receiving units on the suitability of the selected PZ/LZ.
- Becoming familiar with the security, safety, and technical peculiarities of the loads that may adversely affect air transport.
- Providing all components of the 5,000- and 10,000-pound tie-down assemblies used for internal transport in helicopters. (The supported unit is still responsible for packaging and providing disposition instructions to the aviation unit.)
- Arranging for the aircraft to be at the PZ on schedule.
- Establishing safety procedures that ensure uniformity and understanding of duties and responsibilities between the ground and flight crews.

Receiving unit. The receiving unit selects and controls the LZ and provides trained ground crews to guide in the aircraft. Receiving unit responsibilities also include:

- Coordinating with the supported (sending) unit for retrograde of items that belong to the supporting unit.
- Preparing, coordinating, and inspecting back loads and having them ready for loading when the aircraft arrives.

Tie-Down Rings

Several types of cargo restraint devices can be used to tie down cargo. Tie-downs must be correctly attached to prevent cargo from shifting. Each tie-down has a rated strength to prevent cargo from shifting.

UH-1 Iroquois. The tie-down rings in the floor of the UH-1 have a rated holding capacity of 1,350 pounds in the vertical direction and 500 pounds in the horizontal direction. The restraint criteria are 4 g's forward, 2 g's aft, 2 g's vertical, and 1.5 g's lateral. Table 2-2 shows cargo compartment dimensions by model. Figure 2-12 shows the tie-down fittings of a UH-1.

Table 2-2. Dimensions of cargo compartments by model

	UH-1C/M	UH-1D/H
Height of floor above ground	26 in	32 in
Cargo compartment		
Length	60 in	92 in
Width	80.5 in	96 in
Height	56 in	52 in
Cargo door		
Width	48 in	92 in
Height	48 in	49 in

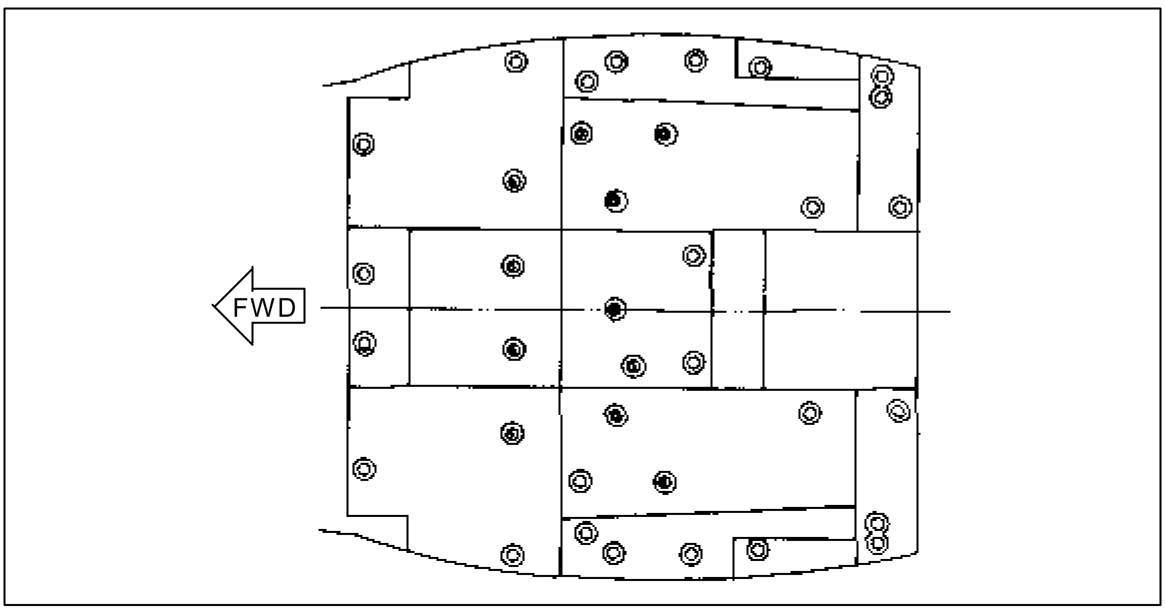


Figure 2-12. UH-1 tie-down rings

UH-60 Blackhawk. The tie-down rings in the floor of the UH-60 have a rated capacity of 5,000 pounds in any direction. The cargo restraint net rings on the walls and ceiling are rated at 3,500 pounds. The restraint criteria are 12 g's forward, 3 g's aft, 3 g's vertical, and 8 g's lateral with troops and cargo; 2 g's in the lateral criterion with cargo only. Table 2-3 shows internal cargo loading specifications. Figure 2-13 shows the tie-down fittings of a UH-60.

CH-47 Chinook. The CH-47 has eighty-seven 5,000-pound capacity tie-down rings (83 in the fuselage and 4 on the ramp) and eight 10,000-pound capacity tie-down rings in the cargo compartment. The restraint criteria are 4 g's forward, 2 g's aft, 4 g's down, 2 g's up, and 1.5 g's lateral. Figure 2-14, page 2-18 shows the tie-down fittings of a CH-47.

Table 2-3. UH-60 internal cargo loading specifications

SECTION	MAXIMUM CAPACITY (lb)	MAXIMUM LB/ SQ FT	SQUARE FEET
Forward cabin	5,460	300	18.2
Center cabin	8,370	300	27.9
Aft cabin	8,370	300	27.9

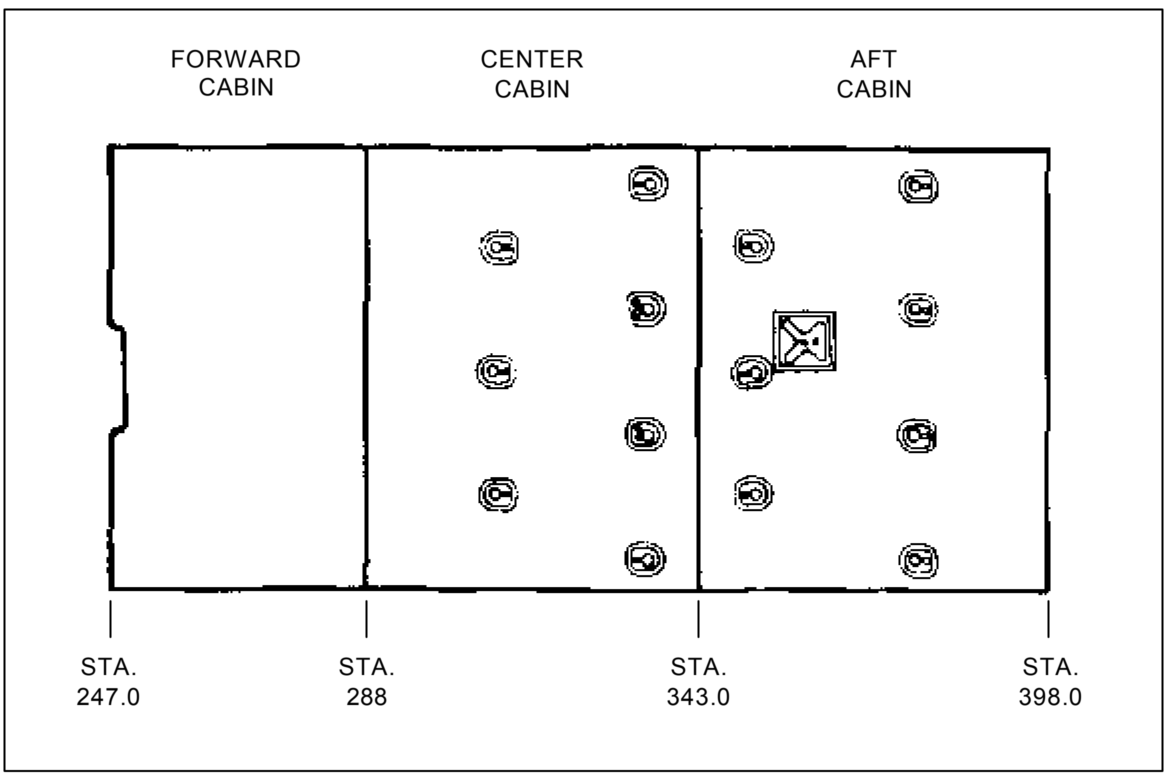


Figure 2-13. UH-60 tie-down rings

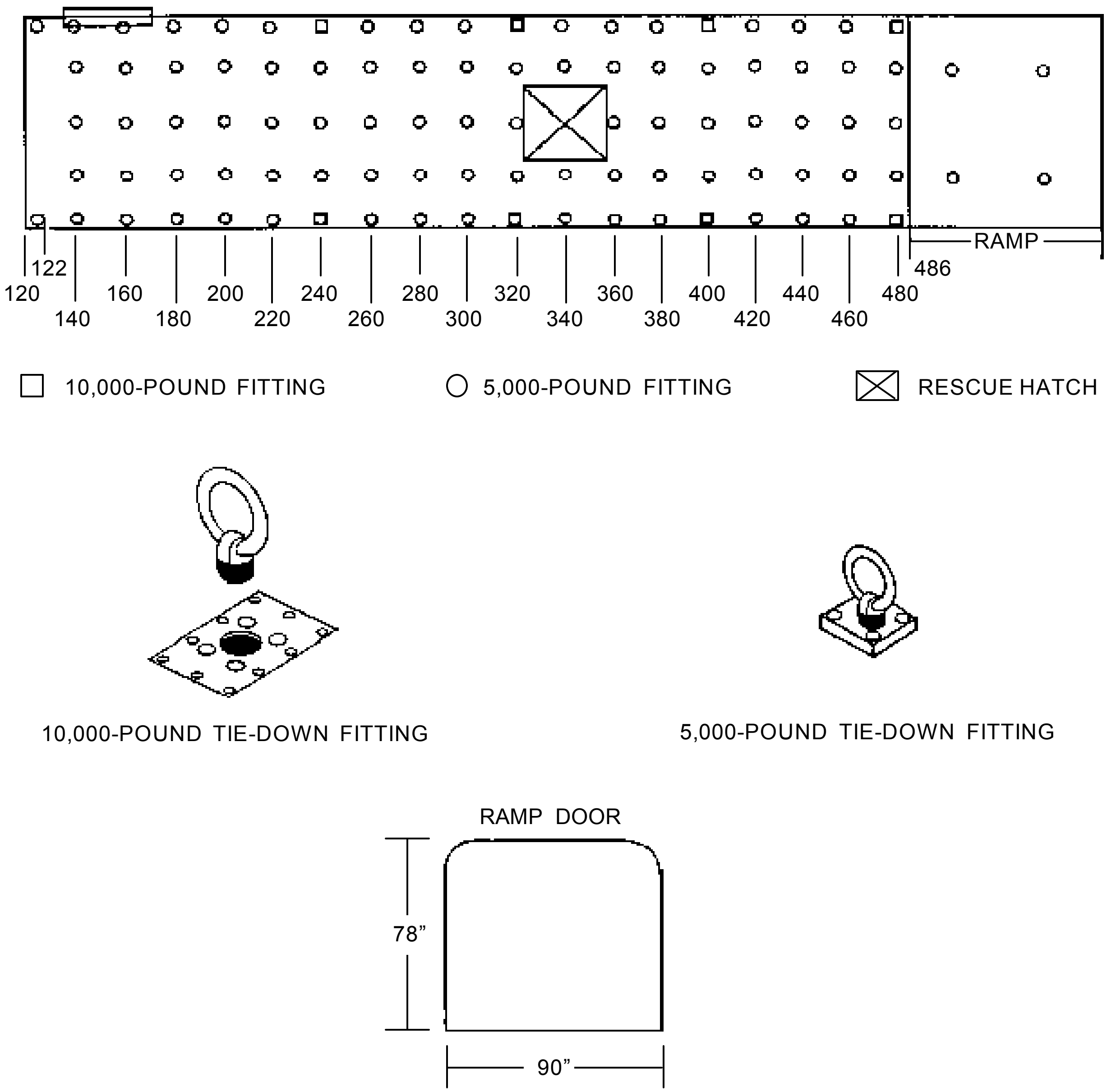


Figure 2-14. CH-47 tie-down rings

Loading/Unloading System

The HICHS is a roller system designed for the CH-47 helicopter (Figure 2-15, page 2-19). This system expedites the loading and unloading of 463L Air Force pallets and other modularized cargo. With the HICHS installed, a CH-47 can carry three (88- by 108-inch) 463L pallets or 12 (40 by 48-inch) standard warehouse pallets. The height of all loads is restricted to 54 inches. The HICHS can be installed by four men in 45 minutes and removed in 20 minutes.

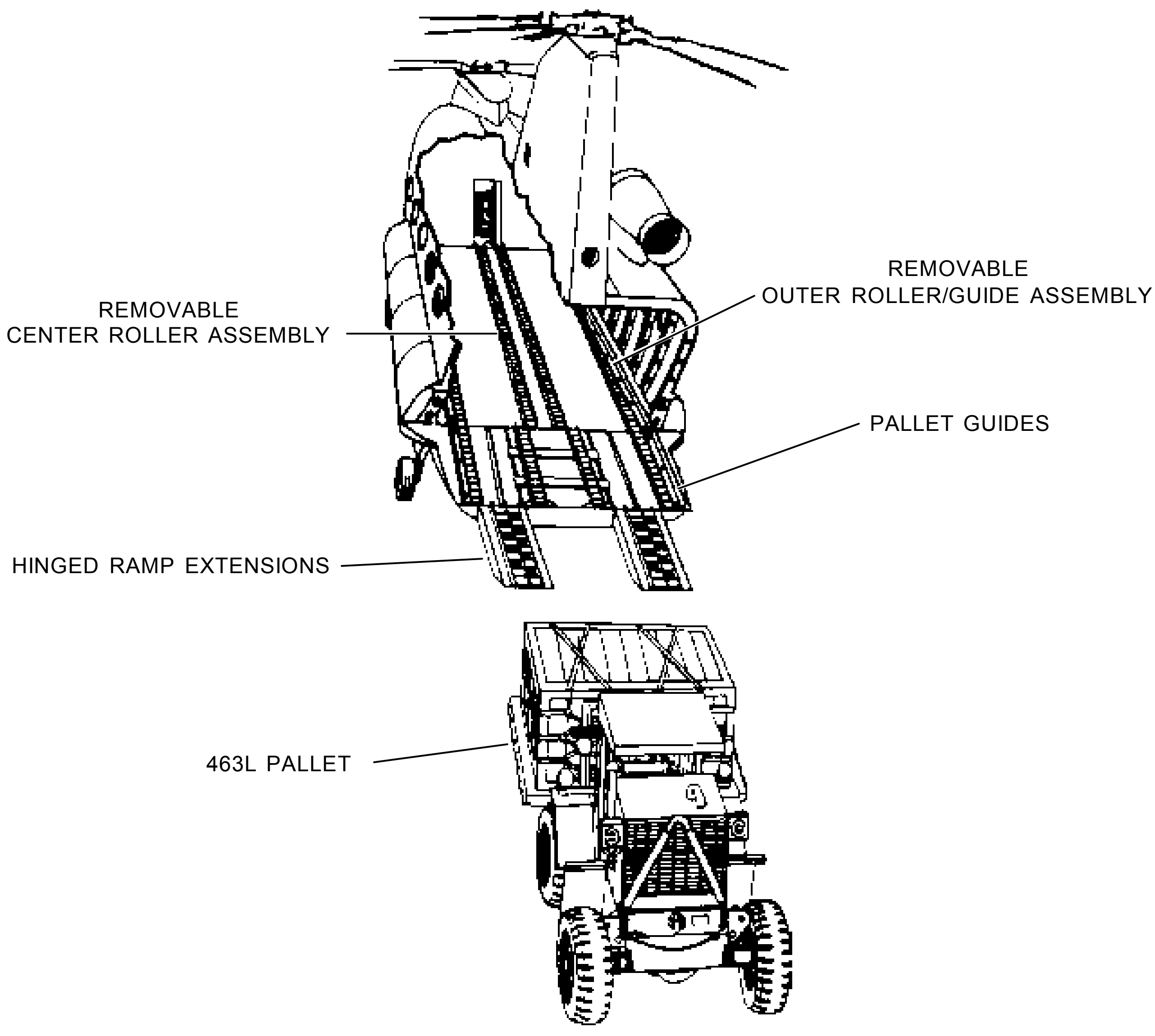


Figure 2-15. HICHS installed in a CH-47 helicopter

Equipment Deployment and Storage Systems

EDSS are standardized unit deployment/storage systems capable of strategic and tactical delivery by both surface and air transport. The QUADCON is the ground dominant system and the ISU the air dominant system.

The ISU is a weather resistant box with a 463L pallet bottom. It is certified for helicopter internal/ external lift, transport on AMC aircraft, and combat off-load. The two versions of this system are the ISU-60 (60 inches high) and the ISU-90 (90 inches high). ISU characteristics are as follows:

- Base – 88- by 108-inches.
- Capacity – 5,000 pounds, internal helicopter lift; 10,000 pounds, airlift or helicopter external lift.
- Usable cubic feet – 225 (ISU-60), 400 (ISU-90).
- Double doors on both 108-inch sides.
- Adjustable shelves and dividers.
- Two-high stackable.
- Two-way forkliftable.
- Completely intermodal.

Figure 2-16 shows characteristics of both the 60-inch and 90-inch ISU. The QUADCON is discussed in Chapter 5 of this manual.

AIR MOBILITY COMMAND AIRCRAFT

Personnel who prepare load plans must be familiar with the types and characteristics of available airlift aircraft. Most significant of these are the C-130, C-141B, C-5, KC-10, and C-17. All are primarily transport aircraft. Their cargo compartments can be configured to accommodate general bulk or palletized cargo, vehicles, troops, paratroopers, and cargo rigged for airdrop. All have long-range mission capability, roller-conveyor systems for using the 463L pallet system, and hydraulically activated ramp systems for ease in loading and off-loading. The broad capabilities of these aircraft allow great flexibility in moving troops and equipment. See FM 55-9 for detailed loading guidance and schematics.

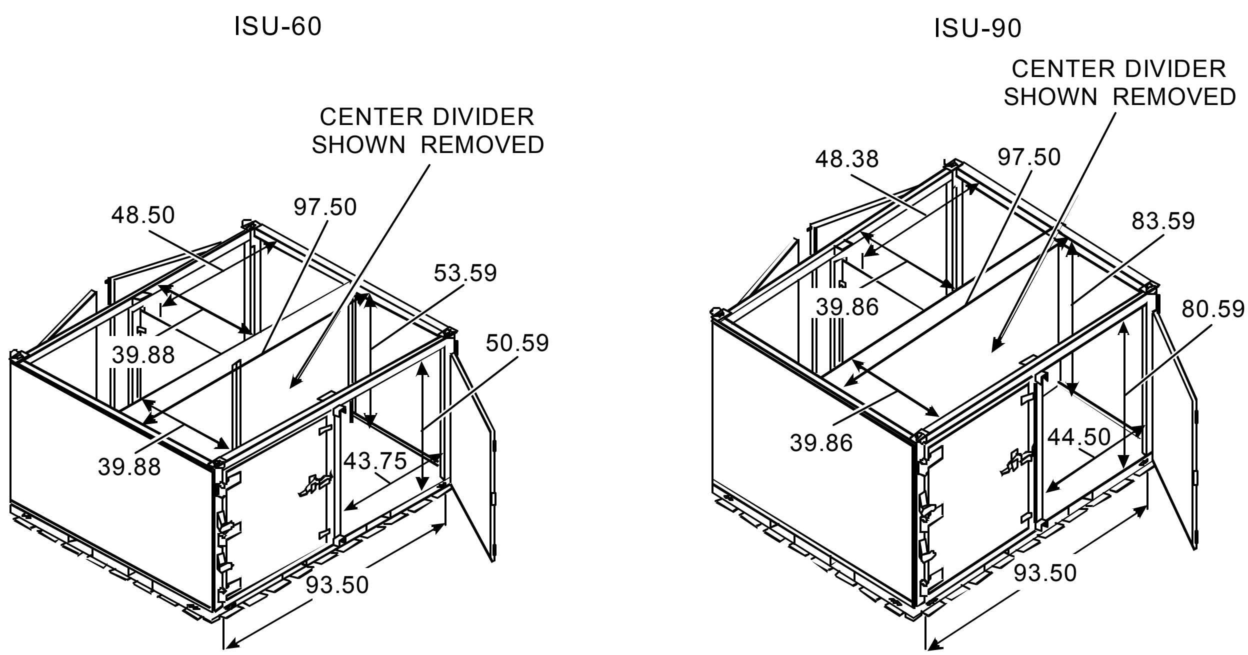


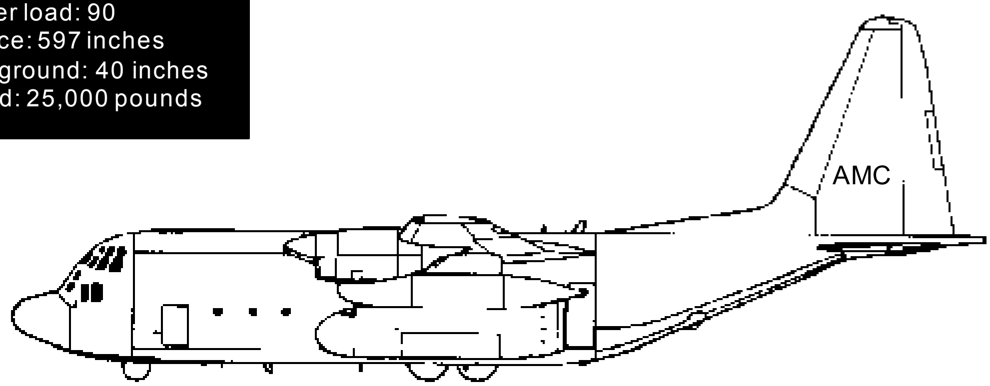
Figure 2-16. ISU characteristics

C-130E/H Hercules

The C-130E/H series Lockheed aircraft is a high-winged, four-engine, turbo-prop medium-range assault transport designed for tactical/theater-type missions. It is the primary aircraft used by Air Mobility Command for tactical missions.

The C-130 does not have a separate passenger compartment. When using side-facing seats, plan for a maximum of 29 passengers. The C-130 can carry up to 90 passengers (80 over water based on life raft capacity). See Figure 2-17 for C-130 characteristics.

- Maximum passenger load: 90
- Usable loading space: 597 inches
- Floor height above ground: 40 inches
- Allowable cabin load: 25,000 pounds



DIMENSIONS

	Cargo Compartment	Troop Door	Aircraft Ramp
Length	624 inches	—	132 inches
Height	108 inches [1]	72 inches	—
Width	23 inches	36 inches	—

PALLETIZED CARGO RESTRICTIONS

Pallet Position	Maximum Weight	Maximum Height
1-4	10,355 pounds	96 inches [2]
5	8,500 pounds	96 inches [2]
6	4,664 pounds	76 inches

NOTE: C-130E/H aircraft can carry six 463L pallets .

RESTRAINT FACTORS

Forward	3.0 g's
Aft	1.5 g's
Vertical	2.0 g's
Lateral	1.5 g's

[1] Only 106 inches of usable floor space is available when the Dual Rail System is installed.

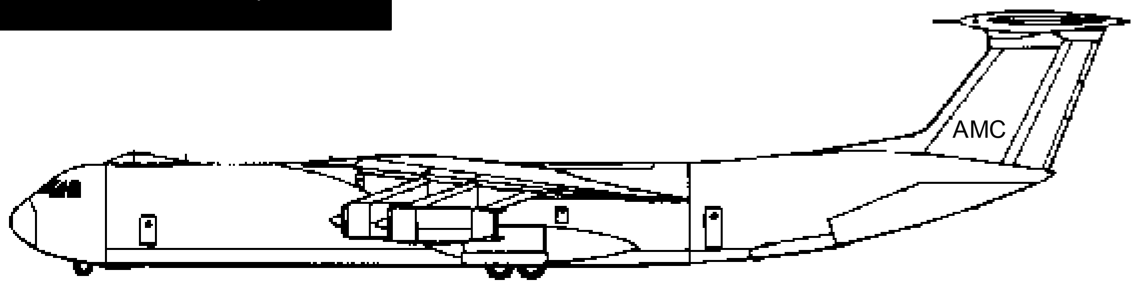
[2] Maximum cargo weight on a single pallet secured with nets stacked above 96 inches (not to exceed 100 inches) shall not exceed 8,000 pounds.

Figure 2-17. Characteristics of C-130E/H aircraft

C-141 Starlifter

The C-141 series Lockheed aircraft is a high-swept-wing, turbo-fan-jet airplane designed for strategic, intertheater-type missions. Like the C-130, the C-141 does not have a separate passenger compartment. When using side-facing seats, plan for a maximum of 98 passengers. The C-141 can carry a maximum of 200 passengers (160 over water based on life raft capacity). See Figure 2-18 for C-141 characteristics.

- Maximum passenger load: 200
- Usable loading space: 1,215 inches
- Floor height above ground: 50 inches
- Allowable cabin load: 50,000 pounds



DIMENSIONS	Cargo Compartment	Troop Door	Aircraft Ramp
Length	1,253 inches	—	133 inches
Height	109 inches	72 inches	—
Width	123 inches	36 inches	—

PALLETIZED CARGO RESTRICTIONS

Pallet Position	Maximum Weight	Maximum Height
1	10,355 pounds	76 inches
2-12	10,355 pounds	96 inches [1]
13	7,500 pounds	76 inches

NOTE: C-141 aircraft can carry thirteen 463L pallets

RESTRAINT FACTORS

Forward	3.0 g's
Aft	1.5 g's
Vertical	2.0 g's
Lateral	1.5 g's

[1] Maximum cargo weight on a single pallet secured with nets and stacked above 96 inches (not to exceed 100 inches) shall not exceed 8,000 pounds.

Figure 2-18. Characteristics of C-141 aircraft

C-5 Galaxy

The Lockheed C-5 is a high-winged, long-range, heavy-lift transport aircraft. It is used for strategic global, intertheater operations. Its primary function is to transport cargo that is outsized or overweight for C-130 or C-141 aircraft. Features unique to the C-5 include the forward cargo door (visor) and ramp and the aft cargo door system and ramp. These features allow drive-on/drive-off loading and unloading as well as loading and unloading from either end of the cargo compartment. The C-5's kneeling capability also facilitates and expedites these operations by lowering the cargo compartment floor by about 10 feet to 3 feet off the ground. This position lowers cargo ramps for truck bed and ground loading and reduces ramp angles for loading and unloading vehicles. The C-5's floor does not have treadways. The "floor-bearing pressure" is the same over the entire floor. As shown in Figure 2-19, page 2-24, however, the C-5 does have weight restrictions. See Figure 2-19 for C-5 characteristics.

The C-5A/B can carry up to thirty-six 463L pallets. The troop compartment is located in the aircraft's upper deck. It is self-contained with a galley, two lavatories, and 73 available passenger seats (CB at FS 1675). Another 267 airline seats may be installed on the cargo compartment floor (maximum combined total of 329 troops including air crew over water).

Passenger Computation Example Problem:

73 troops at 210 pounds each

73 troops x 210 pounds = 15,330 pounds

Center of balance of troop compartment = Fuselage Station 1675 (constant)

Weight x Distance = Moment

15,330 x 1675 = 25677750

KC-10A Extender

The KC-10A series aircraft is a swept-wing, wide-body tri-jet that both air-refuels military aircraft and airlifts cargo and support personnel. Fuel tanks are contained in the lower compartments of the fuselage. Troops, palletized and mixed cargo, vehicles, and logistics equipment are carried on the unobstructed upper deck. The KC-10A can carry up to 69 passengers over water. It accommodates up to twenty-seven 463L pallets. Normally, a maximum of 25 pallet positions are authorized. Besides being equipped to air-refuel military airplanes requiring either a boom or hose drogue, the KC-10A may be refueled from another KC-10A or KC-135 tanker. See Figure 2-20, page 2-25 for KC-10A characteristics.

C-17

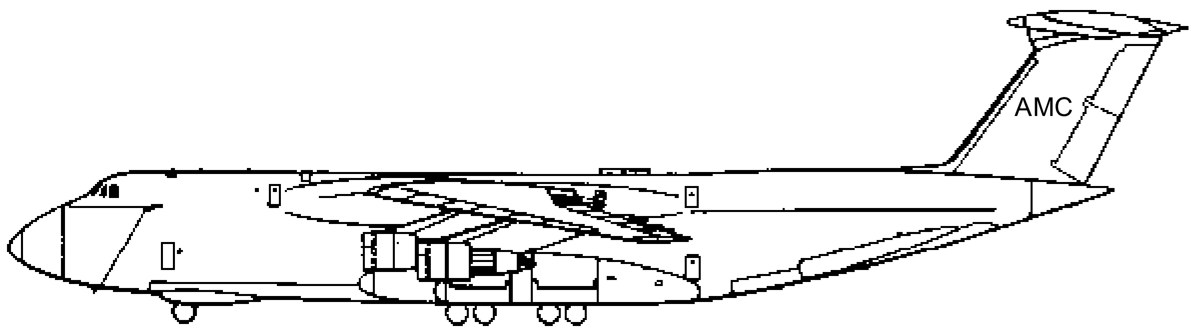
The C-17 is a high-winged, long-range, heavy-lift four-engine turbofan transport aircraft. It is designed to replace the aging C-141 fleet as airlift workhorse, combining the best attributes of today's airlift aircraft with proven modern technology to support tomorrow's battlefields effectively. The C-17 will provide worldwide airlift of US forces.

The C-17 wingspan is about the same as that of the C-141, but with twice the payload. It is capable of delivering the same outsize equipment as the C-5 into small austere airfields previously restricted to the C-130. Its ability to land on short runways with payloads up to 172,200 pounds will make possible the delivery of equipment to forward areas without intermediate transshipment. The C-17 can airdrop or LAPES outsize equipment (single items up to 60,000 pounds, total weight up to 110,000 pounds). It can also provide aeromedical airlift and augment special operations.

The C-17 accommodates up to eighteen 463L pallets. Although it does not have a separate passenger compartment, it has 54 side-facing seats permanently installed in the cargo compartment. With centerline seats installed on the cargo floor, the C-17 can carry a maximum of 102 passengers. See Figure 2-21, page 2-26, for C-17 characteristics.

- Maximum passenger load:
  - 73 normal contingency
  - 267 cargo compartment
- Usable loading space: 1,726 inches
- Floor height above ground: (variable):
  - Aft: 73 to 105 inches
  - Forward: 36 to 70 inches
- Allowable cabin load:
  - Peacetime – 150,000 pounds
  - Wartime – 150,000 pounds
  - Max design ACL – 291,000 pounds

Weight Restrictions
- Maximum axle load: 1884 and 1971: 20,000 pounds
- Maximum tracked vehicle weight: 129,000 pounds
- Floor limitations: maximum axle weight(s) per 40-inch longitudial area between fuselage stations:
  - 517 and 724: 20,000 pounds
  - 724 and 1,884: 36,000 pounds
  - 1,884 and 1,971: 20,000 pounds



DIMENSIONS

	Cargo Compartment	Troop Door	Aircraft Ramp
Length	1,736 inches	—	116 inches (fwd) 155 inches (aft)
Height	162 inches	72 inches	—
Width	228 inches	36 inches	—

PALLETIZED CARGO RESTRICTIONS

Pallet Position	Maximum Weight	Maximum Height
1-2	7,500 pounds	96 inches
3-34	10,355 pounds	96 inches
35-36	7,500 pounds	70 inches

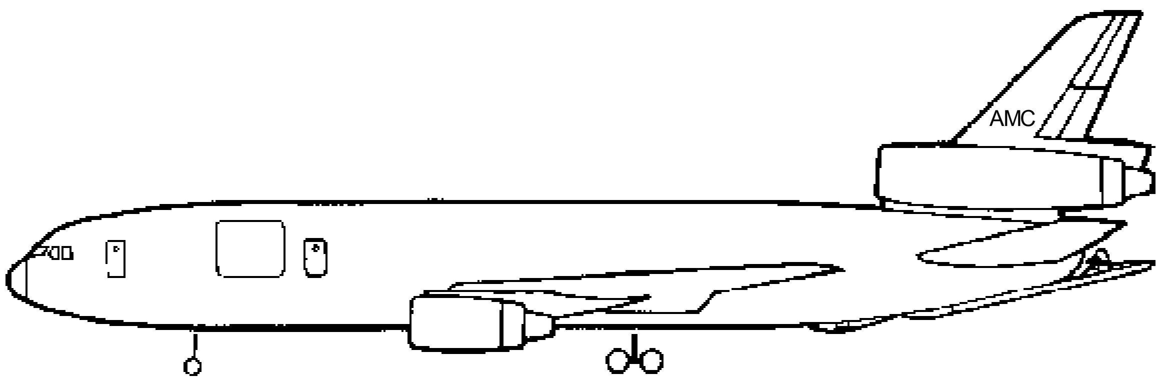
NOTE: C-5 aircraft can carry up to thirty-six 463L pallets .

RESTRAINT FACTORS

Forward	3.0 g's
Aft	1.5 g's
Vertical	2.0 g's
Lateral	1.5 g's

Figure 2-19. Characteristics of C-5 aircraft

- Maximum passenger load:
  - without seat kit: 16
  - with seat kit: 75
- Usable loading space: 1,058 inches
- Floor height above ground: 15 feet 10 inches
- Allowable cabin load: Because of the many types of load configurations (troops, cargo, and fuel) possible, the ACL varies significantly. Contact your local TALCE to get the ACL for the load you wish to transport.

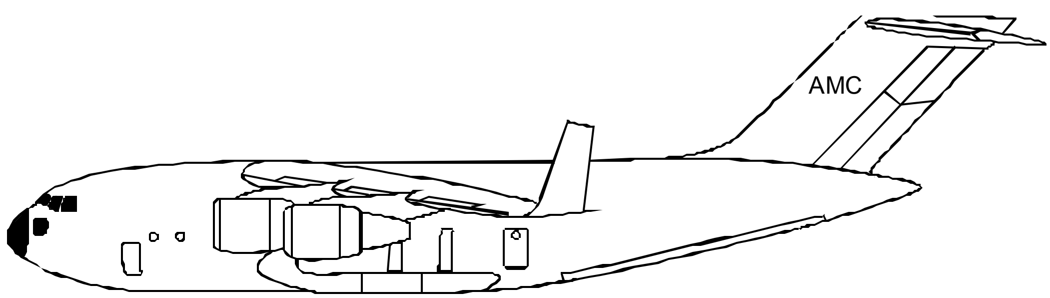


DIMENSIONS

	Cargo Compartment	Troop Door	Aircraft Ramp
Length	1,508 inches	—	—
Height	95 - 131 inches (variable)	76 inches	102 inches
Width	144 inches	42 inches	140 inches

Figure 2-20. Characteristics of KC-10A aircraft

- Troop Configuration (102 total seats)
  - 54 integral side seats
  - 48 center seats
- Usable loading space: 1,022 inches
- Double-row logistics system: eighteen 463L pallets
- Single-row aerial delivery system: eleven 463L pallets
- Constant strength flow: no treadways
- Tie-down ring capacity: 25,000 pounds
- Maximum floor cargo capacity: 172,200 pounds
- Maximum takeoff weight: 580,000 pounds
- Aeromedical evacuation capacity: 48 litters
- LAPES single platform capacity: 60,000 pounds
- LAPES multiple platforms capacity: 110,000 pounds
- CDS capacity: 40 containers at 2,350 pounds total rigged weight each
- Onboard winch system: high-capacity variable-speed
- Landing capability: 2,700 feet long runway with maximum payload of 167,000 pounds



DIMENSIONS

	Cargo Compartment	Troop Door	Aircraft Ramp
Length	1,056 inches	238 inches	—
Height	148-162 inches (variable)	128 inches	80 inches
Width	216 inches	216 inches	43 inches

RAMP LIMITATIONS

	Weight	Height
Pallet	10,355 pounds [1]	96 inches
Vehicle	27,000 pounds per axle	122 inches

[1] Not to exceed a combined total ramp weight of 40,000 pounds.

Figure 2-21. Characteristics of C-17 aircraft

CIVIL RESERVE AIR FLEET AIRCRAFT

The Civil Reserve Air Fleet is made up of US civil air carriers who are committed by contract to providing operating and support personnel for DOD. The CRAF program is designed to quickly mobilize our nation's airlift resources to meet DOD force projection requirements. CRAF airlift services are divided into four operational segments:

- Long-range international-strategic intertheater operations.
- Short-range international theater operations.
- Domestic CONUS-DOD supply distribution.
- Alaskan-Aerospace Defense Command support.

Capability

The CRAF airlift capability can be activated in three stages. These stages are as follows:

Stage I. Stage I may be activated by the USCINCTRANSCOM,[1] to perform airlift services when the AMC airlift force cannot meet simultaneously both deployment and other traffic requirements.

Stage II. Stage II is an additional airlift expansion identified for an airlift emergency which does not warrant national mobilization but may be activated by authority of the SECDEF.[1]

Stage III. Stage III makes available the total CRAF airlift capability when required for DOD operations during major military emergencies involving US Forces. The SECDEF[1] issues the order to activate CRAF stage III only after a national emergency has been declared by the President or Congress.

Description

Table 2-4, page 2-28, gives the dimensions and Table 2-5, page 2-29, gives the capabilities for Boeing B747 series aircraft; Tables 2-6, page 2-30, and 2-7, page 2-31, give the same data for the Douglas DC-10 and Lockheed L-1011 series aircraft; and Tables 2-8, page 2-32, and 2-9, page 2-33, give like data for the Douglas DC-8 and Boeing B707 series aircraft. Figure 2-22, page 2-34, shows profiles of CRAF aircraft; Figure 2-23, page 2-35, shows profiles of CRAF pallets.

Boeing B747. The Boeing B747 is a wide-body aircraft. The cargo-carrying versions have a planning cargo weight of about 180,000 pounds. The main deck can hold either 32 to 36 military or 28 commercial pallets. The passenger version carries about 364 passengers (only 237 on the B747SP).

Douglas DC-10 and Lockheed L-1011. The Douglas DC-10 and Lockheed L-1011 are wide-body aircraft. The cargo-carrying version of the DC-10 has an average cargo weight of about 120,000 pounds. The main deck can hold either 30 military or 22 commercial pallets. The passenger version of the DC-10 can carry about 242 passengers. The L-1011 passenger version has a capacity of 246 to 330 seats.

Douglas DC-8 and Boeing B707. The Douglas DC-8 and Boeing B707 are narrow-body aircraft. The DC-8 cargo version has a planning cargo weight that varies from 52,000 to 82,000 pounds. The main deck accommodates 14 to 18 pallets, depending on the aircraft series. The cargo version of the B707 has a planning cargo weight of about 60,000 pounds, and the main deck can carry 13 military or commercial pallets. The passenger DC-8 carries 165 to 219 passengers, and the B707, approximately 165 passengers. CRAF aircraft are neither designed nor intended to carry litter patients.

NOTE: Unit load plans or request for specific type aircraft is not necessarily the type of aircraft you will receive. Type aircraft received is controlled and driven by the total commitment of tonnage and passengers to be moved and specific airline type aircraft available.

[1] SECDEF memo indicates USCINCTRANSCOM activates all three stages with approval of the SECDEF.

Table 2-4. Dimensions of B747 series aircraft

	AIRCRAFT DESIGNATION				
	B747SP	B747-100/200	B747-100F	B747-200C	B747-200F
Floor height					
Main deck	188-196 in	193-201 in	193-210 in	186-204 in	186-204 in
Lower deck	108-122 in	109-121 in	109-121 in	109-121 in	109-121 in
Main deck cargo compartment					
Length	NA	NA	NA	NA	NA
Width	NA	NA	NA	NA	NA
Height	NA	NA	NA	NA	NA
Lower Lobe (fwd)					
Length	315 in	315 in [1,5] 504 in [6]	504 in	504 in	504 in
Width	125 in [2]	125 in [2]	125 in [2]	125 in [2]	125 in [2]
Height	66 in [3]	66 in [3]	66 in [3]	66 in [3]	66 in [3]
Lower Lobe (aft)					
Length	120 in	251 in [4,5] 436 in [6]	240 in	240 in	436 in
Width	125 in [2]	125 in [2]	125 in [2]	125 in [2]	125 in [2]
Height	66 in [3]	66 in [3]	66 in [3]	66 in [3]	66 in [3]
Door Sizes					
Visor door	104 in w x 98 in h				
Main cargo door	122 in w x 120 in h				

[1] Pallets will not be planned for use in lower lobe forward compartment of American/United Airlines B747-100 passenger aircraft.

[2] Floor width, 125 inches or 190 inches wall-to-wall; however, all cargo must be on pallets or shoring.

[3] Measured from top of rollers to ceiling.

[4] Use 251 inches for American/United Airlines B747-100.

[5] With galley installed in lower lobe.

[6] Without galley installed in lower lobe.

Table 2-5. Capabilities of B747 series aircraft

	AIRCRAFT DESIGNATION				
	B747SP	B747-100/200	B747-100F	B747-200C	B747-200F
Max auth gross weight					
Takeoff	670,000 lb	750,000/ 775,000 lb	750,000 lb	775,000 lb	820,000 lb
Landing	465,000 lb	585,000/ 564,000 lb	575,000 lb	833,000 lb	833,000 lb
Operating	326,000 lb	375,000/ 369,820 lb	327,000 lb	367,000 lb	349,000 lb
Zero fuel	425,000 lb	526,000/ 526,500 lb	545,000 lb	590,000 lb	590,000 lb
Restraining factors					
Forward	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Aft	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Vertical	2.0 g's	2.0 g's	2.0 g's	2.0 g's	2.0 g's
Lateral	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Passenger capacity	266[1]	364[1]	2	364[1]	2
Planning ACL	NA	NA	89.9 STONs	96.9 STONs[2]	99.1 STONs
463L pallet capacity	NA	NA	32[3]	32[3]	32[3]
Max pallet height	NA	NA	118 in	94 in[5]	118 in[4] 94 in[5]

[1] Maximum passenger capability will vary according to carrier configuration.

[2] Since this is a convertible aircraft, figures are based on cargo or passenger loads.

[3] Some aircraft may be configured to a 36-pallet configuration.

[4] Side door.

[5] Visor door.

Table 2-6. Dimensions of DC-10 and L-1011 series aircraft

	AIRCRAFT DESIGNATION				
	DC-10-10CF	DC-10-30CF	DC-10-40	L-1011-100	L-1011-500
Floor height					
Main deck	189 in	189 in	189 in	182-186 in	182-186 in
Lower deck	103-118 in	103-118 in	103-118 in	105-112 in	105-112 in
Main deck cargo compartment					
Length	1,414 in [1]	1,414 in [1]	NA	NA	NA
Width	218 in	218 in	NA	NA	NA
Height	84-95 in [2]	84-9 in [2]	NA	NA	NA
Lower Lobe (fwd)					
Length	491 in [3]	216 in [4]	491 in [3]	500 in [5] 254 in [6]	394 in
Width	125 in [7]	125 in [7]	125 in [7]	125 in	
Height	66 in [8]	66 in [8]	66 in [8]	64 in	64 in
Lower Lobe (aft)					
Length	241.5 in	241.5 in	241.5 in	250 in	190 in
Width	125 in [7]	125 in [7]	125 in [7]	125 in [7]	125 in
Height	66 in [8]	66 in [8]	66 in [8]	64 in	64 in
Lower lobe (aft, bulk compartment)					
Length	179 in	179 in [9]	179 in [9]	167 in	167 in
Width	125 in [10]	125 in [10]	125 in [10]	125 in	125 in
Height	66 in [10]	66 in [10]	66 in [10]	64 in	64 in [10]
Door Sizes					
Main cargo door	140 in w x 102 in h				
Forward and center door	70in w x 66 in h				
Aft door	44 in w x 48 in h				

[1] Length from FS 523 to 1937. A barrier net is located at FS 495. Usable cargo space is based on pallet surface.

[2] Max height of 84 inches at pallet positions 1 and 15; 88 inches at positions 2 through 14; 95 inches at the forward half of the cargo door.

[3] Length from FS 604.5 to FS 1095.5.

[4] Length from FS 879.5 to FS 1095.5.

[5] Without galley installed in lower lobe.

[6] With galley installed in lower lobe.

[7] Wall-to-wall distance is 164 inches.

[8] Measured from top of rollers to ceiling.

[9] Aircraft with an extended aft cargo compartment will have a 126-inch aft bulk cargo area and a cargo door 30 inches wide by 36 inches high.

[10] Dimension decrease toward aft of cargo compartment.

Table 2-7. Capabilities of DC-10 and L-1011 series aircraft

	AIRCRAFT DESIGNATION				
	DC-10-10CF	DC-10-30CF	DC-10-40	L-1011-100	L-1011-500
Max auth gross weight					
Takeoff	440,000 lb	572,000 lb	570,000 lb	466,000 lb	510,000 lb
Landing	363,500 lb	424,000 lb	403,000 lb	368,000 lb	368,000 lb
Operating	247,000 lb	237,591 lb	367,800 lb	246,000 lb	245,000 lb
Zero fuel	335,000 lb	401,000 lb	368,000 lb	320,000 lb	330,000 lb
Optimum load CG at fuselage station	1,323	1,323	1,323	NA	NA
Restraining factors					
Forward	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Aft	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Vertical	2.0 g's	2.0 g's	2.0 g's	2.0 g's	2.0 g's
Lateral	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Passenger capacity	242[1]	242[1]	242	273	238
Planning ACL	55.2 STONs[1]	75 STONs[1]	NA	NA	NA
463L pallet capacity	30	30	NA	NA	NA
Max pallet height	78-82 in	78-82 in	NA	NA	NA

[1] Figures on CFs are for ACLs or passengers, depending on the mode of aircraft use.

Table 2-8. Dimensions of DC-8 and B707 series aircraft

	AIRCRAFT DESIGNATION					
	DC-8-33F	DC-8-50CF	DC-8-61CF	DC-8-62F	DC-8-63F/CF	B707-300C/F
Floor height						
Main deck	126-135 in	126-135 in	128-132 in	126-130 in	126-131 in	119-126 in
Lower deck	68-92 in	68-97 in	75-98 in	73-100 in	76-98 in	54-63 in
Main deck cargo compartment						
Length	1,176 in [1]	1,176 in [1]	1,622 in [2]	1,265 in [3]	1,622 in [2]	1,176 in [4]
Width	127.2 in	127.2 in	127.2 in	127.2 in	127.2 in	126 in
Height	86 in [5]	86 in [5]	86 in [5]	86 in [5]	86 in [5]	87 in [6]
Lower lobe (fwd)						
Length	330 in [7]	330 in [7]	437 in	370 in	437 in	298 in
Width	100 in	100 in	100 in	100 in	100 in	
Height	51 in [8]	51 in [8]	51 in [8]	51 in [8]	51 in [8]	54 in [9]
Door size						
Main cargo door	140 in w x 85 in h					134 in w x 91 in h

[1] Length from FS 302 to FS 1478.

[2] Length from FS 62 to FS 1684.

[3] Length from FS 262 to FS 1527.

[4] Length from FS 242 to FS 1418.

[5] Measured from floor to ceiling.

[6] Measured on centerline to ceiling.

[7] Measurement for entire forward cargo compartment.

[8] Lowest point in cargo compartment to ceiling.

[9] Height of aft cargo compartment 54.5 in for the first 80 in, then tapering down.

Table 2-9. Capabilities of DC-8 and B707 series aircraft

	AIRCRAFT DESIGNATION					
	DC-8-33F	DC-8-50CF	DC-8-61CF	DC-8-62F	DC-8-63F/CF	B707-300C/F
Max auth gross weight						
Takeoff	315,000 lb	315,000 lb	325,000 lb	350,000 lb	355,000 lb	336,600/ 333,100 lb
Landing	207,000 lb	240,000 lb	250,000 lb	250,000 lb	275,000 lb	247,000/ 247,000 lb
Operating	128,000 lb	131,600 lb	147,506 lb	140,000 lb	147,000 lb	355,000/ 132,174 lb
Zero fuel	192,140 lb	224,000 lb	234,000 lb	230,000 lb	261,000 lb	230,000/ 230,000 lb
Optimum load CG at fuselage station	860.0	860.0	828.0-889.0	836.1-883.8	833.9-883.8	838.3-843.7
Restraining factors						
Forward	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Aft	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Vertical	2.0 g's	2.0 g's	2.0 g's	2.0 g's	2.0 g's	2.0 g's
Lateral	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's	1.5 g's
Passenger capacity	2	165[1]	219[1]	170[1]	219[1]	165
Planning ACL	26.0 STONs	29.9 STONs[1]	47.3 STONs[1]	32.1 STONs[1]	41.4 STONs[1]	29.9 STONs[1]
463L pallet capacity	13	13	18	14	18	13
Max pallet height (in inches)	62-80[2]	62-80[2]	62-80[2]	62-80[2]	62-80[2]	74-80[2]

[1] Figures on CF are for ACLs or passengers, depending on mode of aircraft use.

[2] For actual maximum height, see CRAF pallet profiles (Figure 2-23); a general planning height of 76 inches can be used.

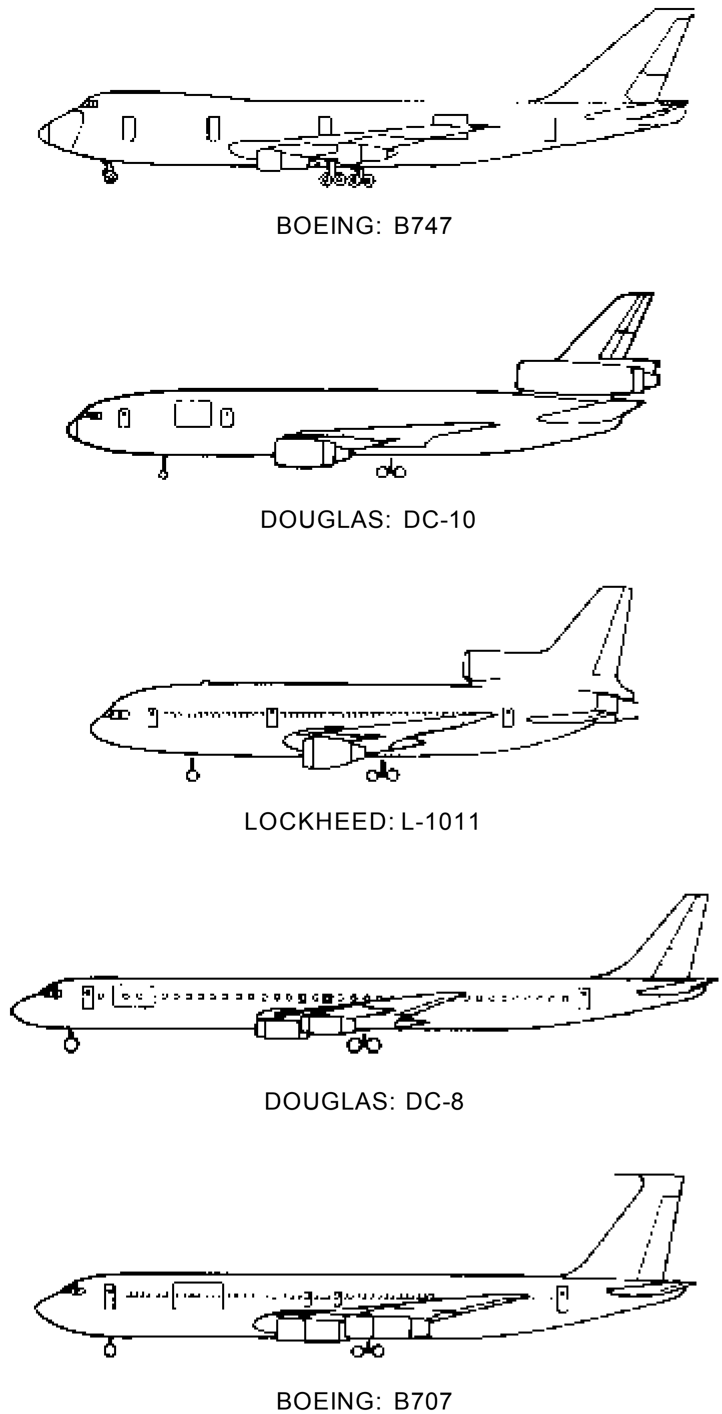


Figure 2-22. CRAF aircraft profiles

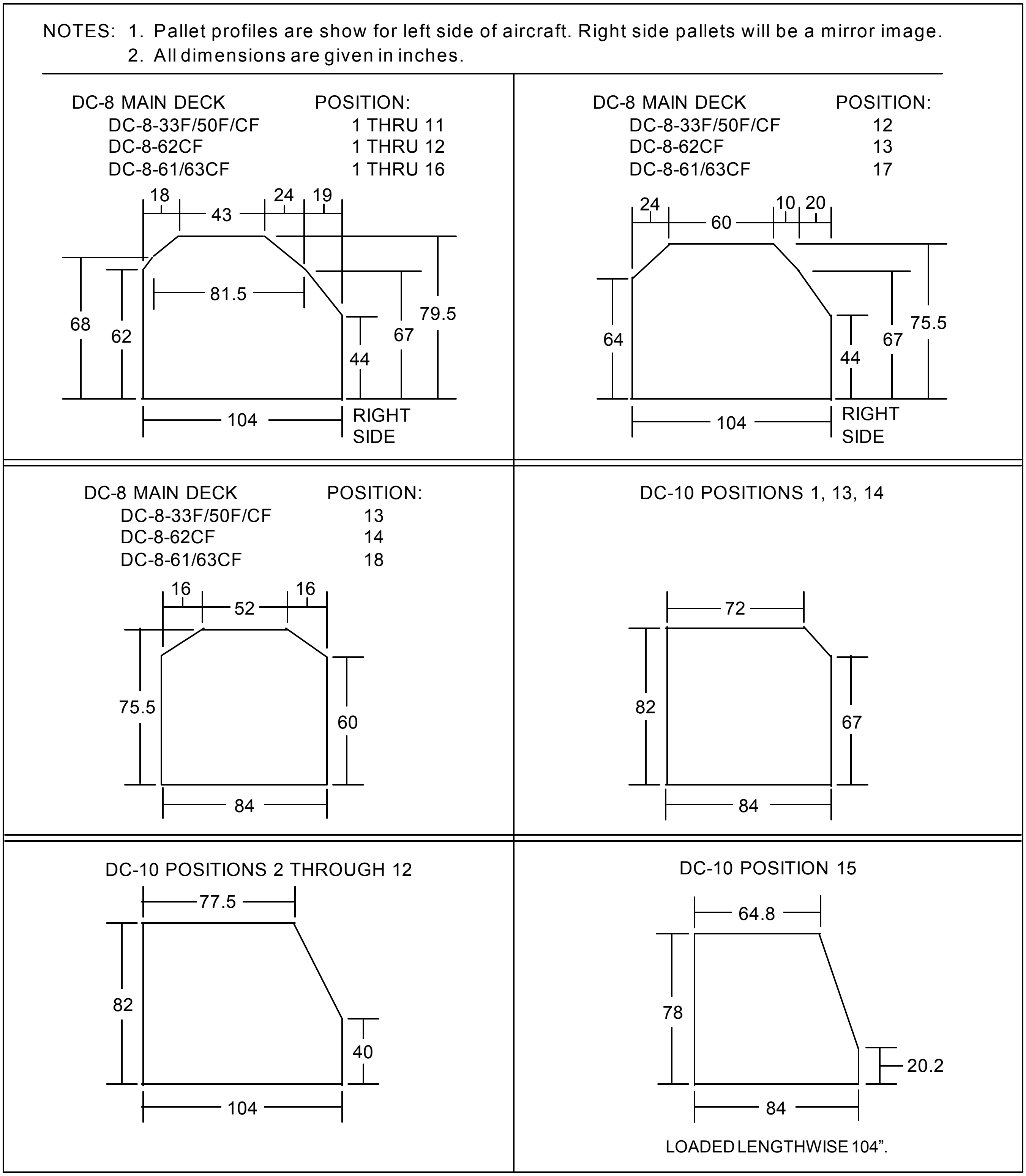


Figure 2-23. CRAF pallet profiles (measurement of pallet surface)

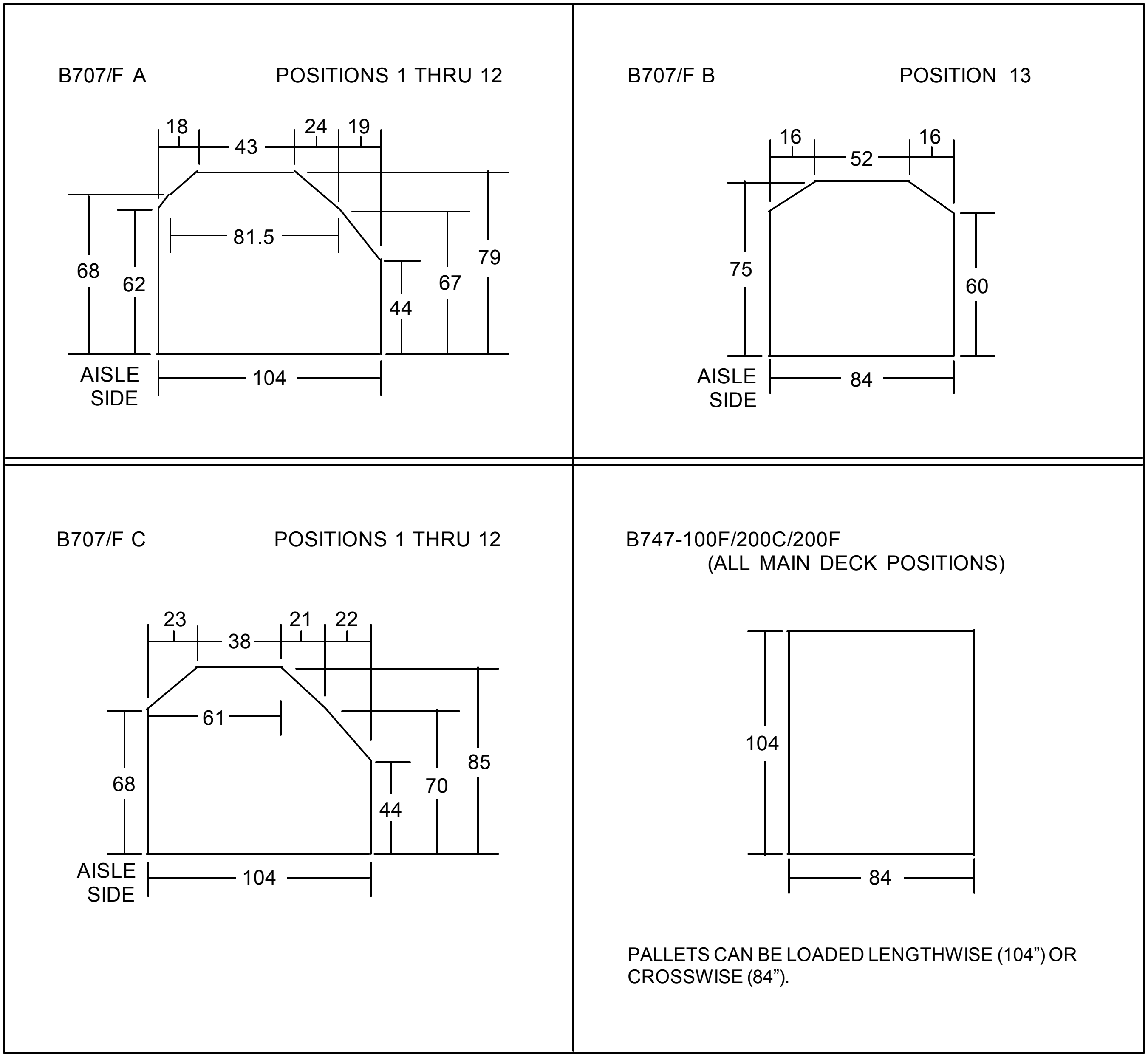


Figure 2-23. CRAF pallet profiles (measurement of pallet surface) (continued)

CHARACTERISTICS OF STANDARD ARMY AIRCRAFT

Tables 2-10 through 2-16, pages 2-37 through 2-44, give data on standard Army aircraft. Tables 2-10 and 2-11, pages 2-37 and 2-39, give capabilities and dimensions for fixed-wing aircraft. Tables 2-12 and 2-13, pages 2-41 and 2-42, give the same data for rotary-wing aircraft. Tables 2-14 through 2-16, pages 2-43 through 2-44, list speed and range factors, preparation times, and sortie capacities. Figure 2-24, page 2-44, shows profiles of Army aircraft.

Table 2-10. Dimensions of Army fixed-wing aircraft
(U-1A, U-10A, and T-41B not included due to their low density)

	UNIT	C-12A	C-12C	C-12D	U-21A	U-21D	U-21F	U-21G
Fuselage length [1]	ft-in	43'10"	43'10"	43'10"	35'10"	35'10"	39'11"	35'10"
Blades								
Length unfolded	ft-in	NA	NA	NA	NA	NA	NA	NA
Length folded	ft-in	NA	NA	NA	NA	NA	NA	
Width folded	ft-in	NA	NA	NA	NA	NA	NA	NA
Tread width	ft-in	17'2"	17'2"	17'2"	12'9"	12'9"	13'0"	12'9"
Extreme height	ft-in	15'5"	15'5"	14'9"	14'2"	14'2"	15'4"	14'2"
Rotor diameter								
Main or fwd	ft-in	NA	NA	NA	NA	NA	NA	NA
Tail or rear	ft-in	NA	NA	NA	NA	NA	NA	NA
Wing span	ft-in	54'6"	54'6"	55'6.5"	45'11"	45'11"	45'11"	45'11"
Cargo door								
Width x height	in	27.7 x 51.5	27.7 x 51.5	52.0 x 52.0	50.5 x 53.0	50.5 x 53.0	17.0 x 51.7	50.5 x 53.0
Location vs fuselage	(left/right front/rear)	left rear	left rear	left rear	left	left	left	left
Cargo floor								
Hgt from ground	in	47"	47"	42"	48"	48"	45"	48"
Usable length	in	128"	128"	128"	110.5"	110.5"	11"	110.5"
Usable width	in	54"	43"	54"	55"	55"	54"	55"
Unobstructed hgt	in	57"	57"	57"	55"	55"	57"	55"
Max cgo space	cu ft	306.5	306.5	306.5	230	230	306	230

[1] Dimension from nose to end of tail.

Table 2-10. Dimensions of Army fixed-wing aircraft
(U-1A, U-10A, and T-41B not included due to their low density) (continued)

	UNIT	U-21H	RU-21A	RU-21B	RU-21C	RU-21D	RU-21H	RU-21J
Fuselage length [1]	ft-in	35'10"	35'10"	35'10"	35'10"	35'10"	35'10"	35'10"
Blades								
Length unfolded	ft-in	NA	NA	NA	NA	NA	NA	NA
Length folded	ft-in	NA	NA	NA	NA	NA	NA	NA
Width folded	ft-in	NA	NA	NA	NA	NA	NA	NA
Tread width	ft-in	12'9"	12'9"	12'9"	12'9"	12'9"	12'9"	12'9"
Extreme height	ft-in	14'2"	14'2"	14'2"	14'2"	14'2"	14'2"	14'2"
Rotor diameter								
Main or fwd	ft-in	NA	NA	NA	NA	NA	NA	NA
Tail or rear	ft-in	NA	NA	NA	NA	NA	NA	NA
Wing span	ft-in	50'11"	50'11"	45'11"	45'11"	45'11"	50'11"	55'6"
Cargo door								
Width x height	in	50.5 x 53.0	50.5 x 53.0	50.5 x 53.0	33.0 x 51.5	50.5 x 53.0	50.5x 53.0	50.5 x 53.0
Location vs fuselage	(left/right front/rear)	left	left	left	left	left	left	left
Cargo floor								
Hgt from ground	in	48"	48"	48"	48"	48"	48"	42"
Usable length	in	110.5"	110.5"	110.5"	110.51"	110.5"	110.5"	128"
Usable width	in	55"	55"	55"	55"	55"	55"	54"
Unobstructed hgt	in	55"	55"	55"	55"	55"	55"	57"
Max cgo space	cu ft	158	158	158	158	158	158	306.5

[1] Dimension from nose to end of tail.

Table 2-11. Capabilities of Army fixed-wing aircraft
(U-1A, U-10A, and T-41B not included due to their low density)

	UNIT	C-12A	C-12C	C-12D	U-21A	U-21D	U-21F	U-21G
Normal crew	per acft	2	2	2	2	2	2	2
Passenger cap								
Troop seats	ea	8	8	8	10	10	10	10
Normal cap	ea	8	8	8	6	6	7	6
Total w/crew	ea	10	10	10	12	12	12	12
Litters/ambt	ea	NA	NA	NA	3/3	3/3	3/3	3/3
Operational cap [1]								
Max auth gross wt	lb	12,500	12,500	12,500	9,500	9,500	11,568	9,650
Basic wt	lb	7,869	8,084	8,084	5,383	5,383	7,012	5,434
Useful load	lb	2,131	4,416	4,416	4,117	4,117	2,756	4,216
Normal payload	lb	2,000	2,000	2,000	2,000	2,000	1,800	2,000
Fuel cap [2]								
Internal	lb/gal	2,470/386	2,470/386	2,470/386	2,457/378	2,457/378	2,405/370	2,457/378
External	lb/gal	NA	NA	NA	NA	NA	NA	NA
Fuel usage [2]	lb/gal per hr	350/538	456/70	456/70	450/72	450/72	450/72	450/72
Normal cruise speed	knots	240	260	260	210	210	220	210
Endurance at cruise	hr + min	6 + 30	5 + 15	5 + 15	5 + 00	5 + 00	4 + 45	5 + 00
(+ 30 min reserve)		NA	NA	NA	NA	NA	NA	NA
Fuel grade	octane	JP4/5	JP4/5	FP4/5	JP4	JP4	JP4	JP4
External cargo								
Max auth load [3]		NA	NA	NA	NA	NA	NA	NA
Rescue hoist	lb		NA	NA	NA	NA	NA	NA
Cgo winch cap	lb	NA	NA	NA	NA	NA	NA	NA
Weapons type		NA	NA	NA	NA	NA	NA	NA

[1] All data was computed at standard conditions at sea level but is subject to change with developmental testing. Detailed weight computations and characteristics were taken from current 55-series TMs.

[2] Aviation gas was figured on 6 lb/gal JP4 computed on 6.5 lb/gal.

[3] The maximum load the aircraft is able to lift.

Table 2-11. Capabilities of Army fixed-wing aircraft
(U-1A, U-10A, and T-41B not included due to their low density) (continued)

	UNIT	U-21H	RU-21A	RU-21B	RU-21C	RU-21D	RU-21H	RU-21J
Normal crew	per acft	2	4 (2 pilots & 2 op)	4 (2 pilots & 2 op)	4 (2 pilots & 2 op)	4 (2 pilots & 2 op)	4 (2 pilots & 2 op)	4 (2 pilots & 2 op)
Passenger cap								
Troop seats	ea	10	NA	NA	NA	NA	NA	NA
Normal cap	ea	6	NA	NA	NA	NA	NA	NA
Total w/crew	ea	12	4	5	4	4	4	4
Litters/ambt	ea	3113	NA	NA	NA	NA	NA	NA
Operational cap [1]								
Max auth gross wt	lb	9,650	10,200	10,900	10,900	9,650	10,200	12,500
Basic wt	lb	5,434	5,450	5,945	5,945	7,170	6,814	8,084
Useful load	lb	4,216	4,750	4,945	4,945	2,480	3.386	4,416
Normal payload	lb	2,000	1,845	1,845	1,845	0	962	2,000
Fuel cap [2]								
Internal	lb/gal	2,457/378	2,405/370	2,574/396	2,574/396	2,405/370	2,405/370	2,470/386
External	lb/gal	NA	NA					
Fuel usage [2]	lb/gal per hr	450/72	580/89.2	580/39.2	580/89.2	580/89.2	580/89.2	456/70
Normal cruise speed	knots	210	205	205	205	205	205	260
Endurance at cruise	hr + min	5 + 00	3 + 45	5 + 00	4 + 15	3 + 45	3 + 45	5 + 15
(+ 30 min reserve)		NA	NA	NA	NA	NA	NA	NA
Fuel grade	octane	JP4	JP4/5	JP4/5	FP4/5	JP4/5	JP4/5	JP4/5
External cargo								
Max auth load [3]		NA	NA	NA	NA	NA	NA	NA
Rescue hoist	lb		NA	NA	NA	NA	NA	NA
Cgo winch cap	lb	NA	NA	NA	NA	NA	NA	NA
Weapons type		NA	NA	NA	NA	NA	NA	NA

[1] All data was computed at standard conditions at sea level but is subject to change with developmental testing. Detailed weight computations and characteristics were taken from current 55-series TMs.

[2] Aviation gas was figured on 6 lb/gal JP4 computed on 6.5 lb/gal.

[3] The maximum load the aircraft is able to lift.

Table 2-12. Dimensions of Army rotary-wing aircraft

	UNIT	CH-47D	UH-1C/M	UH-1D/H/V	UH-60
Fuselage length[1]	ft-in	51’0”	42’7”	40’7”	50’7.5”
Blades					
Length unfolded	ft-in	99’0”	52’10”	57’1”	64’10”
Length folded	ft-in	51’0”	NA	NA	40’4”
Width folded	ft-in	12’5”	NA	8’7”	9’8.1”
Tread width	ft-in	11’11”	8’7”	8’7”	9’8.1”
Extreme height	ft-in	24’5”	12’8”	14’6”	17’6”
Rotor diameter					
Main or fwd	ft-in	60’0”	44’0”	48’0”	44’0”
Tail or rear	ft in	60’0”	8’6”	8’6”	11’0”
Wing span	ft-in	NA	NA	NA	NA
Cargo door					
Width x height	in	90 x 78	48 x 48	74 x 48	68 x 54
Location vs fuselage	(left/right front/rear	rear	left and right	left and right	left and right
Cargo floor					
Hgt from ground	in	NA	22.5”	22.5”	31.2”
Usable length	in	NA	39”	39”	360”
Usable width	in	NA	50”	50”	90”
Unobstructed hgt	in	NA	50”	50”	78”
Max cargo space	cu ft	NA	20	20	1,474

[1] Dimensions from nose to end of tail.

Table 2-13. Capabilities of Army rotary-wing aircraft

	UNIT	OH58C	CH47D
Normal crew	per acfts	1 + (obs)	4
Passenger cap			
Troop seats	ea	4	33
Normal cap	ea	4	33
Total w/crew	ea	4	37
Litters/ambt	ea	2	24
Operational cap [1]			
Max auth gross wt	lb	3,200	50,000
Basic wt	lb	1,898	22,499
Useful load	lb	1,302	27,501
Normal payload	lb	837 [2]	20,206
Fuel cap [3]	lb/gal	465/71.5	6,695/1,030
Fuel usage [3]	lb/gal	175/27	2,600/400
Normal cruise speed	knots	120	145
Endurance at cruise (+30 min reserve)	hrs + min	3 + 00	2 + 30
Fuel grade	octane	JP4	JP4
External cargo			
Max auth load [4]	lb	NA	28,000
Rescue hoist cap	lb	NA	600
Cargo winch cap	lb	NA	3,000
Weapons type [5]		NA	M24

[1] All data computed at standard conditions at sea level, but subject to change with developmental testing. Detailed weight computations and characteristics taken from current 55-series TMs.

[2] Does not meet 200 NM range requirement of normal mission definition.

[3] JP4 was computed on 6.5 lb/gal.

[4] The maximum load the aircraft can lift.

[5] Type of weapons the aircraft can carry.

Table 2-14. Aircraft speed and range factors [1]

AIRCRAFT TYPE	AVERAGE CRUISE SPEED (KN) [2]	FERRY RANGE (NMS)
AH-1	141	381
AH-1S	130	338
CH-47B	114	1,090
CH-47C	111	1,226
CH-47D	136	1,070
CH-54B	100	226
OH-6A	102	330
OH-58	102	260
UH-IC/M	92	300
UH-IH/V	111	276
EH-1H/X	111	276
UH-60A	143	960
C-12A	222	1,177
U-8F	127	1,220
U-21A	180	1,249
OV-1C	200	1,081 [3]

[1] Source is FM 101-20; factors are for ferry mission configuration.
[2] True airspeed under no-wind conditions.
[3] With two 150-gallon external fuel tanks.

Table 2-15. Aircraft preparation times and sortie capacities for airlift [1]

TYPE AIRCRAFT LOADED	AF AIRCRAFT REQUIRED	DISASSEMBLY TIME PER AIRCRAFT		REASSEMBLY TIME PER AIRCRAFT		AIRLIFTED AIRCRAFT PER SORTIE
		Man-Hours	Elapsed Hours	Man-Hours	Elapsed Hours	
AH-LG	C-5	8	2	12	3	12
AH-IS [2]	C-5	8	2	12	2	6
CH-47	C-5	174	32	225	36	3
CH-54	C-5	180	16	225	36	3
OH-6A	C-5	6	3	6	3	26
	C-141A	6	3	6	3	6
	C-130	6	3	6	3	3
OH-58	C-5	1.5	0.5	2	1	13
	C-141A	7.5	1.5	10	3	4
UH-IC/D/H/M/V	C-5	12	3	18	5	8
EH-IH/X	C-5	12	3	18	5	8
UH-6OA [3]	C-5	9	1.5	9	1.5	6
	C-141A	9	1.5	9	1.5	2
UX-8/RU-8	C-5	16	4	32	8	4
U-21	C-5	16	4	32	8	4
OV-IB/C/D	C-5	305	38	750	94	3

[1] Data take n from FM 10 1-20 for minimum disassembly required for air shipment.
[2] AH-IS Cob ras are usually shipped with stub wings on due to excessive reassembly time and boresighting of the TOW system.
[3] UH-60A data taken from TM 55-1520-237-23-4.

Table 2-16. Aircraft preparation times and barge capacities for sealift [1]

AIRCRAFT TYPE	CREW MAN-HOURS	ELAPSED SIZE	HOURS	AIRLIFTED AIRCRAFT [2] SEABEE Barge	LASH Lighter
AH-1G[3]	6.0	3	2.0	144	8
AH-1S	6.0	3	2.0	6	5
CH-47[3]	18.0	6	3.0	Note 4	—
OH-6A[5]	6.0	3	2.0	27	15
OH-58[3]	4.0	3	1.5	14	8
UH-1	5.0	3	2.0	94	6
UH-60A[6]	9.0	6	1.5	6	4
U-2IA[7]	16.0	4	4.0	4	—

[1] Based on minimum disassembly. Preparation times include disassembly, preservation, and crating, as required. Times are rounded off to the next higher 0.5 hours (MTMC Report 74-19).
[2] TM 55-1520-400-14.
[3] MTMC Report 74-19.
[4] SEABEE has capability of loading the following numbers of aircraft on the lower deck if 12 barges are displaced: 48 CH-47s, 3 AH-1GS, 19 UH-lHs.
[5] Estimated by MTMCTEA from TM 55-1520-214-5 and FM 101-20.
[6] Estimate based on information in TM 55-1520-237-23-2 and TM 55-1520-237-23-4.
[7] Estimated by MTMCTEA from TM 55-1500-200-5 and FM 101-20.

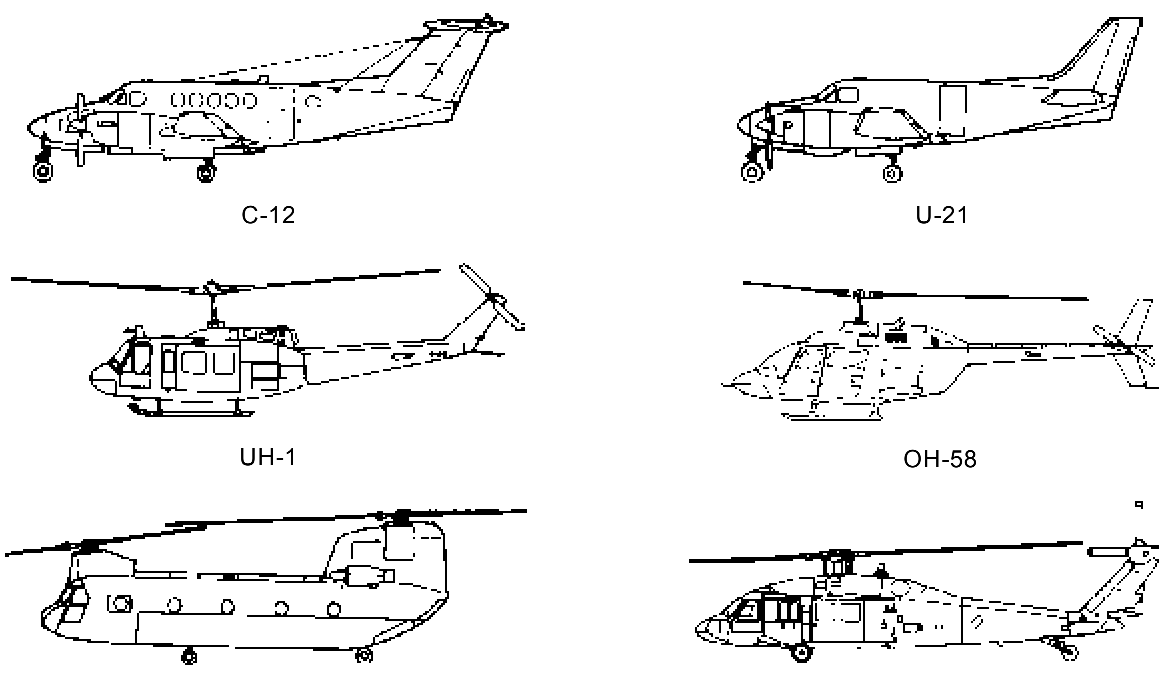


Figure 2-24. Profiles of Army aircraft

Section IV
RESTRAINT CRITERIA

DETERMINING THE CENTER OF GRAVITY

To determine the CG location of a loaded aircraft, you must first know the weight of the aircraft ready for loading, then calculate the weight times the arm to determine the moment.

Arm = the horizontal distance in inches from the reference datum line to the center of gravity of an object.

Moment = the product of the weight of an item multiplied by its arm. Moment may be expressed in pounds-inches; for example, 2 pounds (weight) x 10 inches (arm) = 20 pounds-inches (moment).

The procedures for computing the center of gravity of a loaded aircraft are as follows:

- Calculate for moment. Weight times are = moment.
- List aircraft ready-for-loading weight times the ready-for-loading CG = moment.
- List weight times the arm of each cargo item = moment.
- Add all the weights and enter the total.
- Add all the moments and enter the total.
- Divide the total moments by the total weight; round off any decimals.

This number is the station number at which the aircraft is balanced. If the number does not fall within the safe flight limits, the load or a part of it must be relocated and the aircraft balance recomputed.

Sample Problem (C-141 aircraft)

The C-141 aircraft is loaded with three M35, 2 1/2-ton trucks, each weighing 13,700 pounds, and six passengers (1,800 pounds). All trucks are positioned facing the rear of the aircraft with the CG of truck 1 at station 630, the CG of truck 2 at station 920; the CG of truck 3 at station 1200; and the CG of the six passengers at station 930. The weight of the aircraft ready for loading is 271,000 pounds, with its CG at station 915.

- Weight x arm = moment
- Weight of aircraft ready for loading x CG of aircraft ready for loading
- Weight of one truck x station 630
- Weight of one truck x station 920
- Weight of one truck x station 1200
- Weight of passengers x station 930

271,000	x	915	=	247,965,000
13,700	x	630	=	8,631,000
13,700	x	920	=	12,604,000
13,700	x	1200	=	16,440,000
1,800	x	930	=	1,674,000
313,900 (total weight)				287,314,000 (total moment)

$$\frac{\text{Total moment}}{\text{Total weight}} = \frac{287{,}314{,}000}{313{,}900} = 915.3 \text{ or } 915$$

Station 915 is the CG of the loaded aircraft. The CG limits safe for flight for the C-141 are 906.7 to 948. The aircraft balanced at station 915 is safe for flight.

SECURING CARGO

Tie-down devices secure cargo against forward, rearward, lateral, and vertical movement during takeoff, flight, and landing. To determine the number of devices needed to safely secure any given item of cargo, it is necessary to know the weight of the cargo, restraint criteria for the aircraft, strength of the tie-down devices and fittings, and angles of tie to be used.

Restraint Factors

Restraint factors vary for different aircraft. They are influenced by acceleration during takeoff, stability during flight, deceleration during landing, and the type of landing field (improved or unimproved) for which the aircraft is designed.

Tie-Downs

The effective holding strength of a device (or fitting) is determined by the rated strength of the item and manner in which it is employed. Anchor all tie-downs to a tie-down fitting. The fitting must be as strong as the tie-down. If a tie-down is stressed to its breaking point, the fitting is stressed an equal amount up to the full rated strength of the tie-down. Figure 2-25, page 2-47, shows a typical tie-down correct pull-off.

Number required. There is one basic formula for figuring the restraint for an item of cargo:

WT	=	Weight of cargo
R(g's)	=	Restraint required (g's)
RSD	=	Rated strength of device
% of	=	Percent of angle of tie-down
FTBR	=	Force to be restrained
EHSD	=	Effective holding strength of device

$$\frac{\text{WT} \times \text{R(g's)}}{\text{RSD} \times \text{\% of}} = \frac{\text{FTBR}}{\text{EHSD}} = \text{Total number of devices required}$$

Example:

WT	=	1,000 pounds
R(g's)	=	4
RSD	=	5,000 pounds
% of	=	74.9
FTBR	=	4,000 pounds
EHSD	=	3,745

$$\frac{1{,}000 \times 4}{5{,}000 \times 74.9} = \frac{4{,}000}{3{,}745} = 2 \text{ devices}$$

The weight of the cargo times the restraint force of g's equals the force to be restrained. The rated strength of the tie-down devices times the percent of angle of tie equals the effective holding strength of the tie-down. Use tie-down devices in pairs. If the total number of tie-downs is an uneven number of a decimal, it should be rounded off to the next higher even number.

If the cargo's weight is not marked on a particular item, refer to TB 55-46-1 for its weight and dimensions. The g forces for each direction are found in the applicable aircraft -10 manual. The rated strength of each device is given in Chapter 3 of this manual.

Angle. The percentage of the angle of tie-down is in relation to where the load is tied in the aircraft. See Figures 2-26 and 2-27, page 2-47, for examples of where to figure the angles. For a 30/30 angle of tie, measure from B to C (Figure 2-26) and go one and two-thirds of CB to A; then split the corner angle of DE. For a 45-degree angle, measure one length from B to C, one length to A, then right or left one length.

The recommended angle of tie is the 30/30 angle, as this is the best compromise of tie-down device-holding strength and angle. This tie-down is effective up to 75 percent of its rated strength forward (or aft) to 50 percent vertically and to about 43 percent lateral. Tie-downs secured at a 45-degree angle to the cargo floor and in line with the expected thrust will hold approximately 70 percent of their rated strength against forward, aft, or vertical movements. Tie-downs secured in this manner will hold against movement in two directions. Tie-downs secured at a 45-degree angle to the longitudinal axis of the aircraft prevent cargo movement in three directions: forward (or aft), vertical, and lateral.

These tie-downs will hold about 50 percent of their rated strength against forward (or aft) and lateral movements and 70 percent of their rated strength against vertical movements. To calculate the percentage of angle of tie-down, see Figure 2-28, page 2-48.

Angles across the top are those formed between the tie-down device and the cabin floor. Angles down the side are those formed between the tie-down devices and the longitudinal axis of the aircraft. Vertical restraint is related only to the angle between the tie-down device and the cabin floor. The lateral angle has no bearing on it. The unshaded area indicates the "best compromise" position.

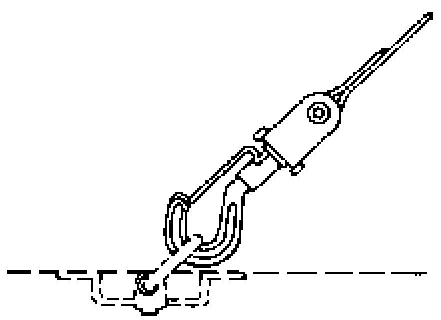


Figure 2-25. Correct pull-off

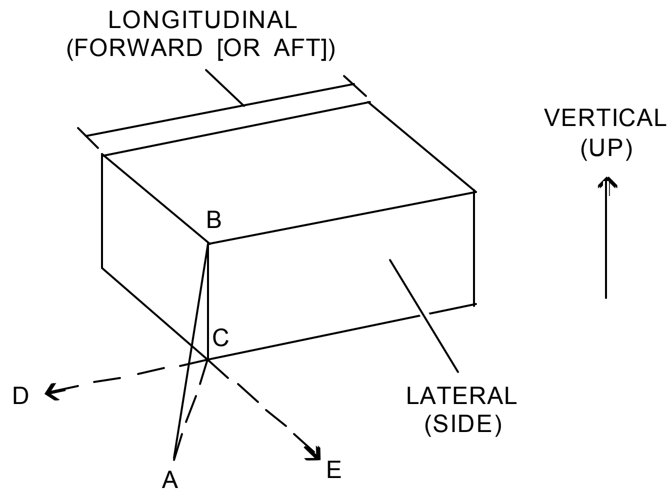


Figure 2-26. Longitudinal angle of tie-down

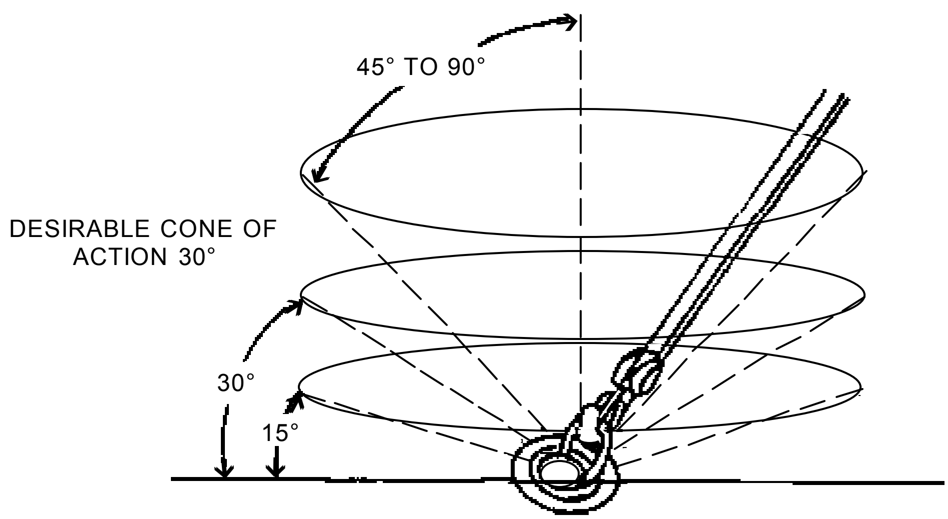


Figure 2-27. Vertical angle of tie-down

		5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°
	VERTI-CAL	8.7	17.4	25.9	34.2	42.3	50.0	57.4	64.3	70.7	76.6	81.9	86.6	90.6	93.9	96.6	98.5
5°	LONG	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3
	LAT	8.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5
10°	LONG	98.1	97.0	95.2	92.6	89.2	85.3	80.7	75.5	69.9	63.3	56.5	49.3	41.7	33.7	25.5	17.1
	LAT	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0
15°	LONG	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8
	LAT	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5
20°	LONG	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6
	LAT	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9
25°	LONG	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8
	LAT	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4
30°	LONG	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1
	LAT	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7
35°	LONG	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3
	LAT	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9
40°	LONG	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3
	LAT	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2
45°	LONG	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3
	LAT	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3
50°	LONG	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2
	LAT	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3
55°	LONG	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9
	LAT	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3
60°	LONG	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7
	LAT	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1
65°	LONG	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4
	LAT	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8
70°	LONG	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9
	LAT	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6
75°	LONG	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5
	LAT	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8
80°	LONG	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0
	LAT	98.1	97.0	95.2	92.6	89.2	85.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1

Figure 2-28. Percentage restraint chart

Section V
AIRDROP

DELIVERY OPERATIONS

Airdrop is a method of delivering supplies and equipment from an aircraft to ground elements. As a rule, airdrop is a joint effort between Army and Air Force elements. Air Force aircraft transport items to the target area and airdrop them. Both Air Force and Army personnel support operations on the ground.

The Army is responsible for providing air-dropped supplies and equipment and airdrop equipment and ground vehicles used in recovering the items. Army divisions and separate brigades possess varying capabilities to support airdrop operations. Normally, airborne or air assault divisions have organic equipment support elements. Armored, infantry, mechanized divisions, and separate brigades require support from corps or theater air delivery units.

Advantages

There are many advantages to airdrop delivery. Supplies and equipment can be delivered directly to units, to otherwise unreachable areas, behind enemy lines, or to special operations units. Airdrop takes less handling and shipping time and reduces exposure of the aircraft to enemy fire. Also, items programmed for emergencies can be prerigged and stored.

Airdrop reduces the need for forward airfields or LZs, congestion during airfield off-loading, and MHE requirements. Airdrop increases aircraft availability and allows greater dispersion of forces.

Disadvantages

Disadvantages to the airdrop method of delivery include the need for specially trained personnel and appropriate airlift aircraft. Each aircraft's capacity and range determine the amount of cargo and number of personnel an aircraft can deliver. Other factors affect the performance of the aircraft, including bad weather and high wind. Helicopters are vulnerable to enemy aircraft and ground fire. Drop zones must be secured to keep items from falling into enemy hands. They require special preparation for LAPES. Also, the bulkiness and weight of equipment rigged for airdrop affect how much an aircraft can carry. Lastly, there is the possibility of loss or damage to equipment.

TYPES OF AIRDROP

Four types of airdrop are used: freedrop, high-velocity, low-velocity, and halo. Factors considered in selecting the appropriate method include threat, type of material to be airdropped, and circumstances of the operation.

Freedrop

No parachute or retarding device is used for freedrop. Energy-dissipating material can be used around the load to ease the shock when the load hits the ground. The load descends at a rate of 130 to 150 feet per second. Fortification or barrier material, clothing in bales, and other such items may be free-dropped.

High-Velocity

Ring-slot cargo, cargo-extraction, and pilot parachutes are used to stabilize loads for high-velocity airdrop. During the decent, the parachute has enough drag to hold the load upright at 70 to 90 feet per second. Items to be air-dropped are placed on energy-dissipating material and rigged in an airdrop container. Subsistence, packaged POL products, ammunition, and other such items may be high-velocity air-dropped.

Low-Velocity

Cargo parachutes are used for low-velocity airdrop. Items are rigged on an airdrop platform or in an airdrop container. Energy-dissipating material is put beneath the load to ease the shock of the load hitting the ground. Cargo parachutes attached to the load reduce the rate of descent to no more than 28 feet per second. Fragile material, vehicles, and artillery may be low-velocity air-dropped.

Halo

The halo is used to air-drop supplies and equipment at high altitudes when aircraft must fly above the threat umbrella. The rigged load is pulled from the aircraft by a stabilizing parachute and free-falls to a low altitude. A cargo parachute then opens to allow a low-velocity landing.

RELEASE METHODS

Loads to be air-dropped may be released by either the extraction, door load, or gravity method.

Extraction

The load and the platform on which it is rigged are pulled from the cargo compartment by an extraction parachute.

Door Load

The load is pushed or skidded out through the paratroop door.

Gravity

The aircraft is flown in a nose-up attitude. The restraint holding the load inside the aircraft is released, and the load rolls out of the cargo compartment.

LOW ALTITUDE PARACHUTE EXTRACTION SYSTEM

LAPES is a method of delivery that uses ring-slotted extraction parachutes to extract palletized loads from low-flying airlift aircraft. It is used to air-drop supplies and equipment from an aircraft flying about 5 to 10 feet above the ground. Energy-dissipating material is put under the load, and the load is rigged on a LAPES airdrop platform. Webbing and load binders hold the load to the platform. The rigged load is pulled from the aircraft by extraction parachutes, which also help slow the platform and load as it slides across the DZ. An airfield or DZ may require special preparation for a LAPES delivery. Vehicles, artillery, ammunition, supplies, equipment, and water may be delivered by LAPES. See Table 2-17 for weight limitations.

Concept of Employment

The LAPES may be the preferred method of delivering supplies or equipment under the conditions specified in this section.

Adverse weather conditions. LAPES should be used when surface or altitude winds exceed drop limitations or ceilings are low and preclude airdrop of equipment in visual meteorological conditions.

Table 2-17. Weight limitations for cargo parachute and aerial delivery container

PARACHUTE	*SUSPENDED WEIGHT IN POUNDS Minimum	Maximum
G-11A	2,270	4,250
G-11B	2,270	5,000
G-12C	501	2,200
G-12D	501	2,200
G-12E	501	2,200
G-13	200	500
T-7A	100	500

CONTAINER	MAXIMUM WEIGHT (16)
A-7A	500
A-21	500
A-22	2,200

* Suspended weight is the total rigged weight less the weight of the cargo parachutes and their riser extensions.

Surface conditions. LAPES should be used in restricted terrain where accuracy is required because of cliffs, mountains, ravines, or other obstacles or when an airfield or assault LZ has been cratered and adequate repair equipment is not available.

Tactical conditions. LAPES should be used when enemy air defense capabilities pose an unacceptable threat to aircraft at normal drop altitudes. Other instances where the use of LAPES may be advisable include:

- When hostile ground fire would pose a threat to an aircraft on the ground.
- When reduced aircraft radar signature is required.
- During clandestine resupply operations, where large loads and increased accuracy are required.

Extraction Zone

Selecting the proper site for an EZ depends on a number of conditions. To ensure safe operation, use specific standards in physically locating and marking an EZ. AMCR 3-3 describes appropriate criteria.

GROUND-AIR EMERGENCY SYMBOLS

The symbols shown in Figure 2-29 can be made with strips of fabric or parachute, pieces of wood or stone, or by tracking in the snow. To be clearly visible from the air, the symbols should be 8 feet or more in length and 10 feet apart. They should also contrast significantly with the background.

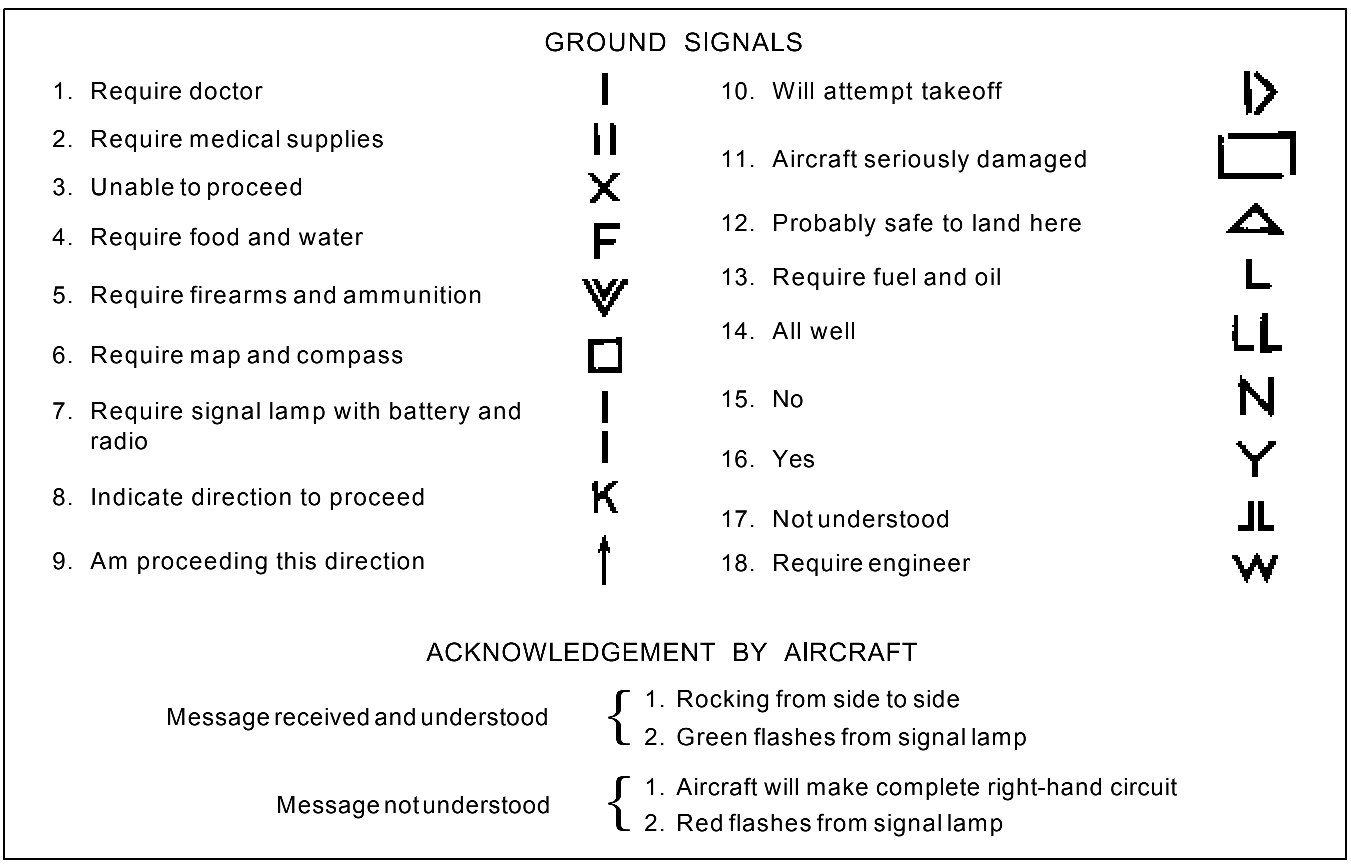


Figure 2-29. Ground-air emergency symbols

CHAPTER 3
MOTOR TRANSPORT

Motor transport is the backbone of the Army's support and sustainment structure, providing mobility on and off the battlefield. Trucks transport personnel, munitions, replacement combat vehicles, petroleum products, critical supply items, and combat casualties. This chapter addresses organizational and operational aspects of the motor transport unit and provides information needed in planning successful operations.

Section I
ORGANIZATION AND OPERATIONS

UNIT ADMINISTRATION

Appendix A contains a breakdown of Army motor transport units according to TOE, mission, assignment, and capability. Figure 3-1 is a sample SOP format for motor transport movements within divisions, logistic commands, and higher echelons. See Figure 3-2, page 3-2, for a sample SOP format for motor transport service. To furnish routine vehicle commitments to subordinate units, use a locally reproduced format. See Figure 3-3, page 3-3, for a sample vehicle commitment work sheet.

____
Classification

STANDING OPERATING PROCEDURE

1. GENERAL. Policies and factors involved in movements.

a. Highway regulation. Purpose, application/scope, responsibilities, methods and procedures.

b. Convoy clearance. Minimum vehicle requirements; convoy symbols; procedures; format for requesting and furnishing clearance; routing; halts; convoy composition; restrictions on tracked, overweight, or outsize vehicles.

c. Highway regulation points. Purpose, basis for, responsibilities and procedures, required records.

d. Traffic control. Responsibilities, relationship to highway regulation, coordination with provost marshal.

e. Return loads. Policies, methods, and procedures for securing and reporting.

f. Convoy commanders. Appointment, responsibilities, and functions; relationships with transportation personnel; instructions to be furnished.

g. Halts. Types; policies, procedures, and responsibilities; area policing.

h. Security. Responsibilities; defensive measures.

i. Records and reports. Responsibilities, methods, required reports.

Figure 3-1. Sample format for motor transport movements SOP

j. Communications. Responsibilities, means of communication.

k. Environment. Protection, spill prevention, transporting HAZMAT.

2. SUPPLY MOVEMENTS

a. Releases. When required, methods of obtaining, formats, dissemination, actions required.

b. Diversions and reconsignments. Authority, request procedures.

c. Records and reports. Types of required records and reports.

Classification

Figure 3-1. Sample format for motor transport movements SOP (continued)

Classification

STANDING OPERATING PROCEDURE

1. GENERAL. Policies for control, operation, and maintenance of facilities equipment, and installation; command responsibility; technical supervision required and agencies involved.

2. MISSION. Service provided, extent of operation.

3. ORGANIZATION. Available operating units, location, and operating limits.

4. FUNCTIONS. Scheduled and nonscheduled operations; maintenance of equipment, including responsibilities, procedures, facilities, and inspection practices.

5. PLANNING. Troop and equipment requirements, capability estimates, communication procedure and requirements, rehabilitation requirements.

6. OPERATIONS. Operational procedures and controls, pooling and equipment use.

7. MAINTENANCE. Responsibilities and procedures for maintenance, regulations, and reports.

8. SUPPLY. Responsibilities for supplies, authorized levels, requisitioning procedures, accounting methods, disposal of excesses.

9. INTELLIGENCE AND RECONNAISSANCE. Responsibilities for collection, collation, evaluation, and dissemination of highway transportation intelligence and reconnaissance information.

10. SECURITY. Responsibilities for disaster and defense plans, convoy and cargo security, equipment and facilities.

11. ENVIRONMENT. Responsibilities and procedures for safeguarding water, vegetation, and wildlife. Spill prevention procedures.

12. RECORDS AND REPORTS. Responsibilities for operational and personnel status reports, technical reports, and miscellaneous records/reports.

13. TRAINING. Responsibilities for unit and technical training.

Classification

Figure 3-2. Sample format for motor transport service SOP

20th Transportation Battalion (Truck)
AE APO 00000

Date 24 Sep '96

Subject: Vehicle Commitment

To: CO 86th Trans Co. Mdm (Cgo)

Commitment No 9-108

1. Vehicles w/drivers: 7-12T S&P

   Report to: Major Eason

   Location: Q200, Warehouse 19

   Time: 0730 Date: 25 Sep '96

   To transport: 77 tons dry rations.

   Destination: Q166, Ludwigsburg - Trans Off. Bldg. A8

2. Remarks: No return load scheduled POL available at Q166 for refueling.

C.H. Mitchell
(Signature)

Major S-3
(Rank & Title)

Figure 3-3. Sample vehicle commitment work sheet

Convoy Briefing

The commander briefs all convoy members before the convoy departs on its mission. A number of topics should be addressed in an effective briefing. With adjustments to local conditions, this briefing should include the following information.

Situation:
- Enemy forces.
- Friendly forces.
- Support units.

Mission:
- Type of cargo.
- Origin.
- Destination.

Execution:
- General organization.
- Time schedule.
- Routes.
- Convoy speed.

- Catch-up speed.
- Vehicle distance.
- Emergency measures (for accidents, breakdowns, and separation from convoy).
- Action of convoy and security personnel if ambushed.
- Medical support.

Administration and logistics:

- Personnel control.
- Billeting.
- Messing.
- Refueling and servicing of vehicles, complying with spill prevention guidelines.

Command and signal:

- Convoy commander's location.
- Assistant convoy commander designation (succession of command).
- Action of security forces commander.
- Serial commanders' responsibilities.
- Arm and hand signals.
- Other prearranged signals.
- Radio frequencies and call signs (for control personnel, security force commanders, fire support elements, reserve security elements, medical evacuation support).

Safety:

- Hazards of route.
- Weather conditions.
- Defensive driving.

Environmental Protection:

- Spill prevention.
- Transporting HAZMAT.

Convoy Commander's Checklist

Before departing, convoy commanders should review the following questions to ensure that arrangements are complete:

- Where is the SP? The RP?
- What route is to be used?
- Has reconnaissance been made? Condition of route determined?
- Can bridges, tunnels, underpasses, and defiles safely accommodate all loaded and tracked vehicles?
- Are critical points known and listed on strip maps?
- What is the size of serials?
- What is the size of march units?
- What is the rate of march?
- What is the vehicle interval on an open road? In built-up areas? At halt?
- What type of column will be used?
- Has provision been made for refueling?
- Has a suitable operations area been selected?
- Have suitable rest- and mess-halt areas been selected?
- Is road movement table needed? Prepared? Submitted?
- Have convoy clearances been obtained? What date?
- Is escort required? Has it been requested?
- Are spare trucks available for emergencies?
- Are vehicles fully serviced and ready for loading?
- Is load properly blocked and braced, neat, and balanced?
- Are drivers properly briefed? By whom? When? Strip maps furnished?
- Is convoy marked front and rear of each march unit? With convoy number when required? Is each vehicle marked? Are convoy flags on the vehicles?
- Are guides in place? Have arrangements been made to post guides?
- Are blackout lights functioning?
- Have maintenance services been alerted?
- Is maintenance truck in rear? Are medics in rear? Is there a loan for casualties?
- Are all interested parties advised of ETA?
- Is officer at rear of convoy ready to take necessary corrective action, such as investigating accidents and unusual incidents and changing loads?
- Who is the trail officer?
- Is there a truck load plan? Who is responsible?
- Is there a truck unload plan? Who is responsible? Do they have the necessary equipment?
- Is there a plan for feeding personnel?
- Have times been established for loading trucks?

- Has time been established for formation of convoy?
- Have times been established for unloading trucks?
- Has time been established for releasing trucks? Who is responsible?
- Is there a carefully conceived plan known to all convoy personnel that can be used in case of an attack?
- Is a written OPORD on hand if required?
- Will a log of road movement be required at end of trip? Are necessary forms on hand?
- Has a weather forecast been obtained?
- Do all personnel have proper clothing and equipment?
- Is there a communications plan? Where will communications equipment be located? Has all communications equipment been serviced?

Convoy Commander's Report

After the move is completed, the convoy commander prepares a report for submission to his immediate superior officer (if required by higher command). A sample report is shown in Figure 3-4, page 3-6. The report may be submitted in the format shown or in the form of a strip map with an appropriate legend attached.

Convoy Clearance

Units that move convoys on MSRs, ASRs, or other controlled routes that require a movement credit (an alphanumeric identifier) must request and receive clearance before beginning movement. A request to move on a controlled route is known as a movement bid. A movement bid is a form or message that details the itinerary of the move, the number and types of vehicles, and movement planning information. The authority to move is passed to the moving unit as a movement credit. The movement bid is submitted through the chain of command to the DTO or Corps/EAC MC detachment within whose area the movement originates. The information required varies according to local regulations. Based on local SOP, as well as the urgency of the requirement, the request may be transmitted in hard copy, electronically, or verbally. In CONUS, DD Forms 1265 and 1266 (Figures 3-5, page 3-8, and 3-6, page 3-10) serve as movement bids. In NATO, STANAGs 2154 and 2155 govern movement bids. Field manuals that contain detailed information on movements bids are FM 55-10 (overseas theaters) and FM 55-312 (CONUS).

In a theater of operations. Before beginning a road movement over a route requiring a movement credit, the unit submits a movement bid through the chain of command as stated above. The movement bid is a dual-purpose document. It can serve either as a request or as an authorization for movement, or both. The requesting agency uses the form to initiate a movement via highway. The movement control organization uses the form to grant clearance and to issue instructions for the road movement. Once the request is received, the movement control organization schedules the movement for the time and over the route requested (if possible). If the move cannot be scheduled at the requested time or on the requested route, the movement control organization notifies the requester. Alternate times and routes are then arranged. After final coordination and approval, the movement control organization issues the necessary movement credit, convoy movement number, and any other required information. The authorization is returned to the requesting agency.

In CONUS. A military convoy must gain permission from the appropriate state and city officials to travel on public highways. To obtain this permission, the following documents should be submitted through the ITO at point of origin:

- DD Form 1265.
- One copy of operations order.
- Four copies of strip map of the proposed convoy route.
- One copy of each document for each state to be crossed.
- One copy of each document for the local ITO.

The request must reach the approving authority (in most cases, the local ITO) at least 10 days before the planned move.

FORWARD LOAD

420 Trans Bn (Trk)		4401 Trans Co (Lt Trk)
28FE0lC (Convoy No)	Twelve 2 1/2-Ton Trucks (No. and type of task vehicles)	16 Feb XX (Date)

TIME

Departed starting point .... 0621 hr
Arrived 1st loading point .... 0630 hr
Departed 1st loading point .... 0800 hr
Time at 1st loading point .... 1 hr 30 min
Arrived HRP .... 1200 hr
Departed HRP .... 1205 hr
Time at 1st unloading point .... 33 min

SUPPLIES AND PERSONNEL

Cargo (STONs) 50.2
Class of supplies I
Number of personnel 0

DISTANCE

Odometer reading of lead vehicle (at 1st loading point) .... 21,324 mi
Odometer reading of lead vehicle (at starting point) .... 21,322 mi
Total forward (no load) .... 2 mi
Odometer reading of lead vehicle (at 1st unloading point) .... 21,381 mi
Total forward (loaded) .... 57 mi

REMARKS

Starting point – company area, RJ 124/167
Weak bridge 6.4 mi east of 1st loading point. Road generally in poor condition between starting point and 1st unloading point.

RETURN LOAD

TIME

Arrived 2d loading point (same as 1st unloading point) .... 1245 hr
Departed 2d loading point .... 1300 hr
Time at 2d loading point .... 15 min
Arrived 2d unloading point .... 1400 hr
Departed 2d unloading point .... 1415 hr
Time at 2d unloading point .... 15 min

Figure 3-4. Sample convoy commander's report

SUPPLIES AND PERSONNEL

Cargo (STONs) 10.0
Class of supplies .... II and IV
Number of personnel 120

DISTANCE

Odometer reading of lead vehicle (at 2d unloading point) .... 21,396 mi
Odometer reading of lead vehicle (at 2d loading point) .... 21,381 mi
Total return (loaded) .... 15 mi
Odometer reading of lead vehicle (at starting point) .... 21,346 mi
Total return (no load) .... 40 mi

REMARKS

Road in excellent condition between 2d loading point and starting point.

ROUND TRIP DATA

TIME

Returned to starting point .... 1,654 mi
Total round trip time .... 10 hr 33 min
Total travel time (including halts) .... 8 hr
Total loading time .... 1 hr 45 min
Total unloading time .... 48 min

SUPPLIES AND PERSONNEL

Cargo (STONs of Class I) 50.2
(STONs of Class II and IV) 10.0
Number of personnel 120

DISTANCE

Total distance (loaded) .... 72 mi
Total distance (unloaded) .... 42 mi
Total round trip distance .... 114 mi

REMARKS

Average rate of march = 14.2 MIH.
Ton-miles forward = 2,861; return = 150.
Passenger-miles forward = 0; return = 1,800.

/s/ ____________________________

/t/ Thomas A. Young
(Convoy commander)

2d Lt, 4401 Trans Co (Lt Trk)
(Rank/grade and organization)

Figure 3-4. Sample convoy commander's report (continued)

REQUEST FOR CONVOY CLEARANCE

DATE: Jan XX

SECTION I - GENERAL

1. ORGANIZATION	2. STATION	3. CONVOY COMMANDER
100th Trans Co (Lt Med Trk)	Fort Eustis, VA 23604	John J. Jones 1LT, TC

4. PERSONNEL STRENGTH a. OFFICER	b. ENLISTED	5. POINT OF ORIGIN	6. DESTINATION
1	47	Fort Eustis, VA	Fort A. P. Hill, VA

7. DATE AND TIME	7a. DEPARTURE	7b. ARRIVAL	8. RATE OF MARCH
	20 0700 Jan XX	20 1002 Jan XX	40 MIH

SECTION II - CONVOY COMPOSITION

9. NUMBER OF EACH TYPE OF VEHICLE AND DESCRIPTION (Include towed equipment)

1 1/4-ton truck, utility
20 5-ton tractor w/19 stake and platform semitrailers (1 bobtail)
1 5-ton wrecker

SAMPLE

10. TOTAL NUMBER OF VEHICLES	11. NUMBER OF OVERSIZE/OVERWEIGHT VEHICLES	12a. NO. OF SERIALS	12b. TIME INTERVAL	13a. NO. OF MARCH UNITS	13b. TIME INTERVAL
22	21	1	NA	2	2 min

SECTION III - ROUTE DATA

14. PROPOSED ROUTING (Indicate US Routes, State Routes, etc)

Interstate 64, State Route 168, State Route 33, Interstate 64, Interstate 95, State Route 207, US 301 to Fort A. P. Hill.

15. ETA AND ETD AT STATE LINES, MAJOR ROAD JUNCTIONS, MAJOR BRIDGES AND TUNNELS, METROPOLITAN AREAS AND OVERNIGHT HALT SITES (Continue on a separate sheet if additional space is required)

LOCATION	ETA	DATE	ETD	DATE
I-64	0700		0705	20 Jan XX
Rt # 168	0732		0737	
15-min rest halt, Rt # 33	0754		0814	
I-64	0835		0840	
I-95	0859		0904	
Rts 207-301	0957		1002	

SECTION IV - LOGISTICAL DATA

16. BRIEF GENERAL DESCRIPTION OF CARGO (Brief general description; i. e., organizational impedimenta, etc.) (Within security limitations)

Class I (packaged rations)

DD FORM 1 JAN 56 1265

Figure 3-5. Sample DD Form 1265, Request for Convoy Clearance

17. ARE EXPLOSIVES TO BE TRANSPORTED? ☐ YES ☒ NO (If YES, describe below)

CLASS	AMOUNT	DESCRIPTION	VEHICLES TO BE USED NO.	VEHICLES TO BE USED TYPE
		NA		

18. STATEMENT WHY EXPLOSIVES CANNOT BE TRANSPORTED COMMERCIALLY (Movements involving explosives and/or other dangerous articles are required to comply with all applicable regulations or directives)

NA

19. LOGISTICAL SUPPORT REQUIRED AT OVERNIGHT HALT SITES? ☐ YES ☒ NO (If YES, complete the following) (Use separate sheet if additional space is required)

DATE	INSTALLATION	GAS (gals)	OIL (gals)	RATIONS	BILLETS	OTHER
	NA					

20. REMARKS

ETA is the time the first vehicle clears the referenced point.

ETD is the time the last vehicle clears the referenced point.

SAMPLE

21. REQUESTING AGENCY	22. APPROVING AGENCY
100th Trans Co (Lt Med Trk)	
23. REQUESTED BY (Typed name, grade and title)	24. APPROVED BY (Typed name, grade and title)
CHARLES C. CHESTNUT	

25. DATE	26. SIGNATURE	27. DATE	28. SIGNATURE
5 Jan XX	Charles C. Chestnut		

INSTRUCTIONS: In cases where bona-fide emergencies exist, the information contained on DD Form 1265 and DD Form 1266 may be transmitted to the appropriate headquarters by telephone or electric transmission. In this event, reference will be made to item numbers in the sequence in which they appear on the form. Items which do not apply will be so indicated.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1973-545-841/9490

Figure 3-5. Sample DD Form 1265, Request for Convoy Clearance (continued)

REQUEST FOR SPECIAL HAULING PERMIT

DATE: 5 Jan XX

SECTION I - GENERAL

1. ORGANIZATION	2. STATION	3. DATE OF MOVEMENT a. STARTING	b. COMPLETION
100th Trans Co (Lt Med Trk)	Fort Eustis, VA 23604	0700 20 Jan XX	1830 21 Jan XX

4. POINT OF ORIGIN	5. DESTINATION
Fort Eustis, VA	Fort Drum, NY

6. ARRIVAL AT STATE LINES

DATE	TIME	STATE LINE
20 Jan XX	1308	VA/MD
20 Jan XX	1440	MD/PA
21 Jan XX	1145	PA/NY

7. ROUTING (Interstate US Routes, State Routes, etc.)

IS 64, VA 168, VA 33, IS 64, IS 95, IS 495E, US1, IS 695, IS 83, IS 81, US 11

8. ESCORT REQUIREMENTS

None

SAMPLE

SECTION II - VEHICLE AND LOAD DATA

DESCRIPTION (a)	TYPE (5-ton etc) (b)	NO. OF VEHICLES (c)	REGISTRATION NUMBER (d)	HEIGHT (e)	WIDTH (f)	LENGTH (g)	WEIGHT (h)
9. VEHICLE							
A. TRUCK							(Empty)
B. TRUCK-TRACTOR	5-ton	8	See Item 12	103.5	98.3	158.3	(Empty) 18,560
C. TRAILER							(Empty)
D. SEMI-TRAILER	12-ton	8	See Item 12	108.3	97.3	348.5	(Empty) 14,240
E. OTHER (Specify)							(Empty)
10. LOAD Orgn Impedimenta							5,000
11. OVERALL (Vehicle and load)				108.3	98.3	526	(Gross) 37,800

12. DESCRIPTION OF LOAD (Brief general description; Organization impedimenta, etc.) (Within security limitations)

Organization impedimenta.

<u>Registration Numbers</u>

Trac		Tlr	Trac		Tlr
5E5551	–	5T9991	5E5555	–	5T9995
5E5552	–	5T9992	5E5556	–	5T9996
5E5553	–	5T9993	5E5557	–	5T9997
5E5554	–	5T9994	5E5558	–	5T9998

13. LOAD OVERHANG	a. FRONT	b. REAR	c. LEFT SIDE	d. RIGHT SIDE
	NA	NA	NA	NA

DD FORM 1 JAN 86 1266

Figure 3-6. Sample DD Form 1266, Request for Special Hauling Permit

14. NUMBER OF AXLES	(1)	A	(2)	B	( )	C	( )	D	( )	E	( )	F	( )	G	( )	

	AXLE 1 a	AXLE 2 b	AXLE 3 c	AXLE 4 d	AXLE 5 e	AXLE 6 f	AXLE 7 g	AXLE 8 h	TOTAL i
15. NUMBER OF TIRES	2	4	4	4	4				18
16. TIRE WIDTH (Inches)	11	11	11	11	11				
17. TIRE SIZES	1100 x 20	1100 x 20	1100 x 20	1100 x 20	1100 x 20				
18. AXLE LOAD (Empty)	8,244	6,958	6,958	5,320	5,320				32,800
19. AXLE LOAD (Loaded)	9,044	8,058	8,058	6,320	6,320				37,800

20. AXLE SPACING (See Item 14 for Identification)	A SPACING	B SPACING	C SPACING	D SPACING	E SPACING	F SPACING	G SPACING
	140	54	162	52			

21. REMARKS

22. MOVEMENT BY HIGHWAY IS
☐ ESSENTIAL TO NATIONAL DEFENSE
☒ IN THE INTEREST OF NATIONAL DEFENSE

SAMPLE

23. REQUESTING AGENCY	24. APPROVING AGENCY
100th Trans Co (Lt Med Trk)	
25. REQUESTED BY (Typed name, grade and title)	**26. APPROVED BY (Typed name, grade and title)**
Charles C. Chestnut, CPT, TC, Commanding	

27. DATE	28. SIGNATURE	29. DATE	30. SIGNATURE
5 Jan XX	Charles C. Chestnut		

INSTRUCTIONS

GENERAL:

DD Form 1266 "Request for Special Hauling Permit" will be used to obtain special hauling permits for the movement of oversize/overweight vehicles over public highways when accompanying a convoy or when traveling separately.

This form, in duplicate and accompanied by letter of transmittal, will be forwarded through the local transportation officer so as to reach the appropriate headquarters not less than ten (10) working days prior to the starting date of the movement. Letters of transmittal will contain complete itinerary and explanation of the movement. One (1) letter of transmittal is sufficient when several DD Forms 1265 and 1266 involving one (1) movement are forwarded to the appropriate headquarters.

In cases where bona-fide emergencies exist, the information contained in this form and DD Form 1265 may be transmitted to the appropriate headquarters by telephone or electric transmission. In this event, reference will be made to item numbers in the sequence in which they appear on the forms. Items which do not apply will be so indicated.

SPECIFIC:

Item 9A, B, C, and D - Complete nomenclature of vehicles involved. More than one unit may be included, provided units are identical in equipment, load characteristics, routing and movement date. Total number of units shall be indicated prominently.

Item 9E - Note all units other than standard highway vehicles; road equipment, guns, etc.

Item 9 (d) - Indicate the registration number for each unit or combination of units. Use additional page if required.

Item 14 - Indicate appropriate number of axles by inserting number in proper circles. Block out circles not applicable.

Item 21 - For movement through the District of Columbia, include name of manufacturer of equipment.

GPO 812717 U.S. GOVERNMENT PRINTING OFFICE : 1955 O-[illegible]

Figure 3-6. Sample DD Form 1266, Request for Special Hauling Permit (continued)

Special hauling permit. In CONUS, the DD Form 1266 is used to request permission to move oversize or overweight vehicles over public roads. Four copies of the form are required, plus a copy for each state to be crossed. The request must reach the approving authority at least 15 days before the planned move. Only identical vehicles with loads of uniform weight and dimensions may be listed on the same DD Form 1266.

PLANNING

Planning ensures the allocation of transportation assets to meet mission requirements based on command priorities and to identify potential shortfalls.

General Planning Factors

Motor transport planning, particularly in its early stages, must be based on a set of broad planning factors and assumptions. These planning factors should be used only in the absence of specific data relating to the current situation. Because of the different services performed, loads carried, and terrain crossed, caution should be exercised when using the following:

- Task vehicle availability rate – the average number of assigned task vehicles not in maintenance and available for daily mission support. See Appendix C for TVAR data on specific vehicle types.
- Vehicle payload capacity – the rated cargo capacity of the vehicle. During planning, the off-road payload capacity of the equipment is used to determine allowable highway load capacities.
- Operational hours per shift – the number of hours per shift in which vehicles and drivers are normally employed. Use 10 hours per shift for planning purposes.
- Operational day – the number of hours per day in which vehicles and drivers are normally employed. Use 20 hours (two 10-hour shifts) per day for planning purposes. The remaining 4 hours of the day are for scheduled maintenance.
- Daily round trips – the average number of daily round trips a vehicle can make per day, use an average of two trips per day (1 trip per shift x 2 shifts) for vehicles involved in line-haul operations and four trips per day (2 trips per shift x 2 shifts) for local haul operations.
- Operational distance per shift – the average one-way distance that cargo can be hauled within allotted operational hours per shift. Use 90 miles/144 kilometers for line-haul operations and 20 miles/32 kilometers for local haul operations.
- Rate of march in the hour – the average number of miles/kilometers that can be covered in an hour (includes all halts during movement). Use 20 MIH (32 KMIH) if traveling over good roads and 10 MIH (16 KMIH) for bad roads. In addition to the road surface, consideration must be given to any terrain, weather, or hostile activity that may effect the rate of march.
- Delay times – basically any time taken away from the physical forward movement of cargo (any time not included in the rate of march). Delay times include loading and unloading, line-haul relay time, rest halts, and any other delays en route that can be anticipated but are not included in rate of march calculations.
  - Straight trucks: 2.5 hours for loading and unloading time per round trip (straight haul).
  - Semitrailers: 2.5 hours for loading and unloading time per round trip (straight haul).
  - Container transporters: 1.5 hours for loading and unloading time per round trip (straight haul).
  - Truck tractors in semitrailer relay operations: 1 hour per line-haul segment (per relay round trip in semitrailer relay operations).
  - Palletized Load System: 0.5 hours for loading and unloading time per round trip (straight haul).

Movement Requirement Formulas

Use the following formulas to compute unit and vehicle requirements on the basis of planning estimates, actual operational data, or a combination of both. Be sure to compute the load in the appropriate commodity unit (STONs, containers, gallons, etc.).

Turnaround time: total time consumed in a round trip movement (including delays). Delay factors must be accurate. To determine turnaround time use the following formula.

$$\text{turnaround time} = \frac{2 \times \text{distance}}{\substack{\text{rate of march} \\ \text{(MIH/KIH)}}} + \text{delays}$$

Unit lift operations: the amount of cargo a truck company can move at one time (one-time lift). To determine the number of vehicles or truck companies to move a given commodity in one lift, use the following formulas.

$$\text{required vehicles} = \frac{\text{commodity quantity to be moved}}{\text{capacity* per vehicle}}$$

$$\text{required companies} = \frac{\text{commodity quantity to be moved}}{\substack{\text{capacity* per vehicle} \\ \times \text{ average number of} \\ \text{vehicles available per company}}}$$

* Appropriate commodity capacity (STONs, containers, gallons, etc.)

Daily lift operations: the amount of cargo a truck company can move in a day making a number of trips. The amount of cargo moved will vary based on running times, delays, terrain, and weather. Use the following formula (steps) to compute the number of truck companies required to move a given amount in sustained operations.

Step 1: Compute the trip turnaround time =

$$\frac{2 \times \text{distance}}{\text{rate of march}} + \text{delays}$$

Step 2: Compute the required companies =

$$\frac{\text{commodity quantity to be moved}}{\substack{\text{capacity per vehicle} \times \text{ average number of vehicles} \\ \text{available per company} \times \text{ operational day}}}$$

The number of vehicles required can be determined by omitting the vehicle availability factor from the formula.

$$\text{required vehicles} = \frac{\text{commodity quantity to be moved}}{\substack{\text{capacity per vehicle} \\ \times \text{ vehicle availability}}}$$

Specific loads: loads consisting of one or more items that, because of their peculiarities, involve a variation in the normal planning process to determine vehicle requirements for the operation. Items may or may not be packaged with unusual size, shape, cube, or weight. In such cases, attempt first to determine vehicle requirements by test loading or by using operational data available from previous similar operations. If test loading is not feasible or operational data unavailable, use the following steps to determine vehicle requirements.

NOTE: The vehicle payload and compartment cube capacity can be obtained from the vehicle data plate, technical manual, or Section II of this chapter. The weight and cubic volume of a specific item or load can be obtained from the shipper, service representative, or applicable technical manual.

Step 1: Determine the number of items that may be loaded onto one vehicle by cargo weight.

$$\frac{\text{vehicle payload capacity}}{\text{weight of item to be transported}}$$

Step 2: Determine the number of items that may be loaded onto one vehicle by cube capacity.

$$\frac{\text{vehicle compartment capacity}}{\text{cube of item to be transported}}$$

If the value using cargo weight is the lesser value, then the weight of the computed load will exceed the vehicle's payload capacity before all available compartment space is filled. If the value using cargo cube is the lesser, the computed cargo load will "cube out" (exceed the cubic cargo space available in the vehicle) before it "weighs out" (exceeds the vehicle payload capacity).

Step 3: Determine the number of vehicles required to transport the load based on mission necessity (one-time lift or daily sustained operation).

$$\frac{\text{number of items to be transported}}{\substack{\text{number of items that can be transported} \\ \text{per vehicle}}}$$

(select the lesser value of Steps 1 and 2)

Local haul calculations: Use the following steps to determine the number of truck companies required to support a local haul network.

Step 1: Compute the turnaround time =

$$\frac{2 \times \text{distance}}{\text{rate of march (MIH)}} + \text{delays}$$

Step 2: Compute required companies =

$$\frac{\text{commodity quantity to be moved} \times \text{turnaround time (from Step 1)}}{\text{capacity per vehicle} \times \text{average number of vehicles available per company} \times \text{operational day}}$$

Local haul backhaul calculations: Use the following steps to determine the number of truck companies required to support a local haul backhaul operation.

Step 1: Compute the turnaround time =

$$\frac{2 \times \text{distance}}{\text{rate of march (MIH)}} + \text{delays}$$

Step 2: Compute required companies =

$$\frac{\text{commodity quantity to be moved} \times \text{turnaround time (from Step 1)}}{\text{capacity per vehicle} \times \text{average number of vehicles available per company} \times \text{operational day}}$$

Step 3: Compute required additional companies =

$$\frac{\text{commodity quantity to be backhaul} \times \text{delay time}}{\text{capacity per vehicle} \times \text{average number of vehicles available per company} \times \text{operational day}}$$

Line-haul calculations: Use the following steps to determine the number of truck companies required to support a line-haul leg.

Step 1: Compute the segment distance =

$$\frac{(\text{operational hours per shift - delays}) \times \text{rate of march}}{2}$$

Step 2: Compute the number of segments required per leg.

$$\frac{\text{total distance to travel}}{\text{segment distance from (Step 1)}}$$

Step 3: Compute the turnaround time =

$$\frac{2 \times \text{distance}}{\text{rate of march (MIH)}} + \text{delays (delay time} \times \text{\# of segments)}$$

Step 4: Compute required companies =

$$\frac{\text{commodity quantity to be moved} \times \text{turnaround time (from Step 3)}}{\text{capacity per vehicle} \times \text{average number of vehicles available per company} \times \text{operational day}}$$

Line-Haul Operational Planning Exercise

The seven procedural steps that follow demonstrate how to systematically plan and establish a motor transport network.

Step 1: Determine requirements and resources available. The following daily cargo tonnage and container (20-foot) requirements are provided by the staff movements officer:

Origin	Destination	STONs	Containers
Red Port	SB #1	1200	100
Red Port	SB #2	900	50
SB #1	SB #2	700	
Bravo Beach	SB #1	500	

By conducting a thorough map reconnaissance, you determine the need for the following transport units to support the transportation network (Figure 3-7, page 3-15):

- Medium truck company, TOE 55727L100 (equipped with M915 tractors and M872 trailers) to support all line-haul operations. To facilitate an efficient port clearance, this truck company will also be used for local haul operations between the port and TT #3.
- Medium truck company, TOE 55728L100 (equipped with M931 tractors and M871 trailers) to support the local haul operations at TT #1 and TT #2.

For the purpose of this exercise use the following planning factors to compute requirements:

- Operational day: 20 hours (two 10-hour shifts).
- Vehicle availability percentage: 84.7 percent.
- Rate of march:

– 32 KIH – between the origin and destination TTs on the MSR.

– 24 KIH – between Port Red and TT #3, TT #1 and SB #1, TT #2 and SB #2.

– 16 KIH – between Bravo Beach and TT #3.

- Delays:

– 2.5 hours per round-trip for all local haul operations (1.25 hours for loading and 1.25 hours for unloading).

– 1 hour per segment (relay round trip) for line-haul operations.

- Vehicle capacity (from Table 3-1, page 3-16, and Table 3-2, page 3-21).

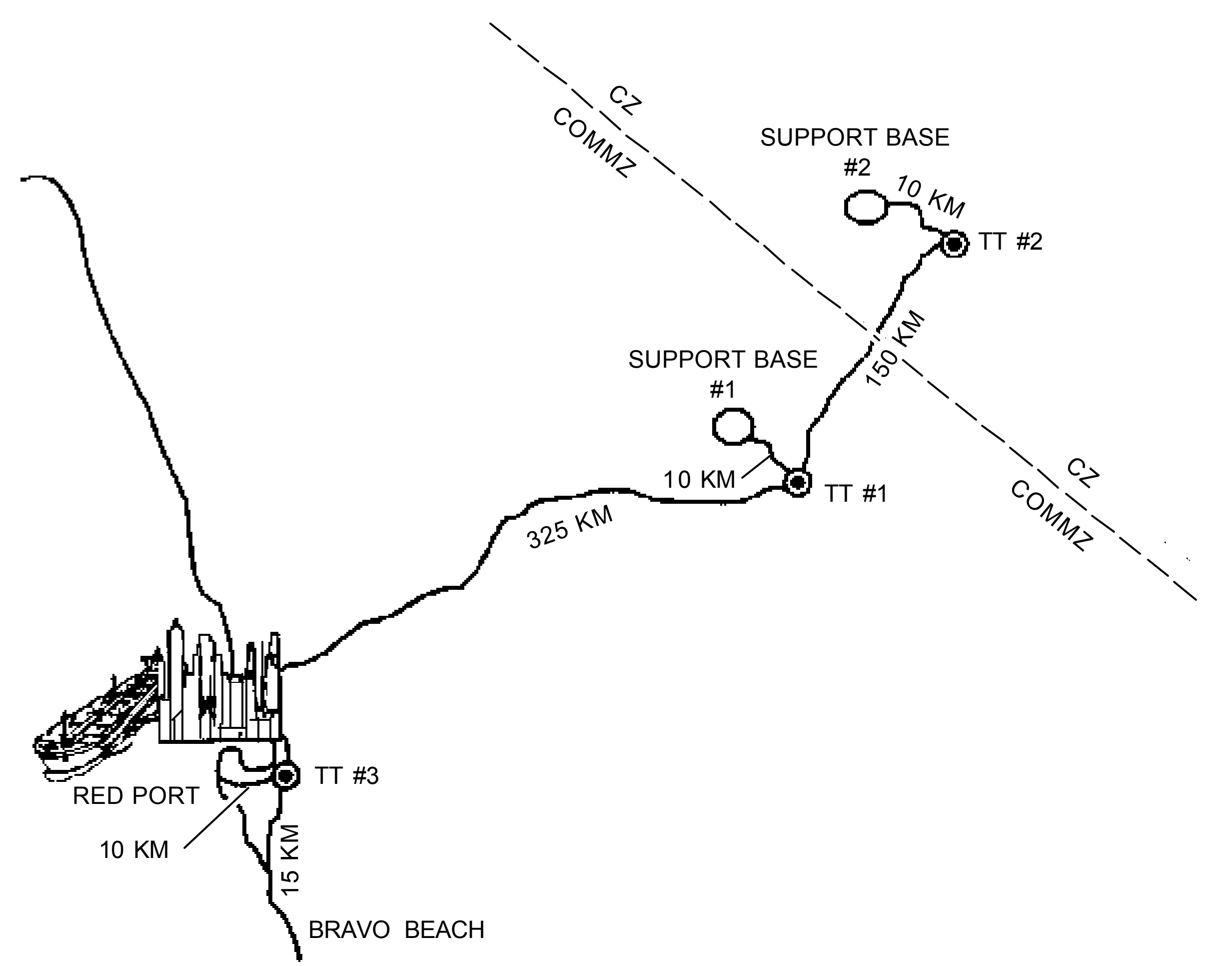


Figure 3-7. Transportation network

Table 3-1. Truck performance data

VEHICLE	PAYLOAD (lb)	MAXIMUM GRADE w/Towed Load	MAXIMUM GRADE w/o Towed Load	MAXIMUM SPEED (MPH)	CRUISING RANGE (mi)	TOWED LOAD ALLOWANCE (lb)	FORDING DEPTH w/o Kit (in)	FORDING DEPTH w/Kit (in)
Small unit support vehicle, M973	4,961	40	60	31	186	NA	NA	NA
Truck, utility, 1/4-T, 4 x 4, M151A1, M151A2	800	60	—	56	300	1,170	21	60
Truck, cargo, 1 1/4-T, 4 x 4, M998	2,500	—	60	65	337	3,400	30	60
Truck, cargo, 1 1/4-T, 4 x 4, M1097	4,400	—	60	65	275	4,200	30	60
Truck, utility, 3/4-T, 4 x 4, M1009	1,200	—	30	55	250	3,000[1]	20	—
Truck, cargo, 1 1/4-T, 4 x 4, M880, M881, M882	1,600	—	30	55	200	3,000	16	—
Truck, cargo, 1 1/4-T, 4 x 4, M883, M884, M885, w/comm shelter	1,600[2]	—	30	55	200	3,000	16	—
Truck, cargo, 1 1/4-T, 4 x 2, M890	1,600[1]	—	30	55	200	3,000[1]	16	—
Truck, cargo, 1 1/4-T, 4 x 4, M1008	2,900	—	30	55	250	3,000	20	—
Truck, cargo, 1 1/4-T, 4 x 4, M1028	3,600	—	30	55	250	3,000	20	—
Truck, cargo, 2 1/2-T, 6 x 6, M35A1	5,000	45	60	56	320	6,000	30	72
Truck, cargo, 2 1/2-T, 6 x 6, M35A2	5,000	45	60	56	300	6,000	30	72
Truck, cargo , 2 1/2-T, 6 x 6, M35A2C	5,000	45	60	56	300	6,000	30	72
Truck, cargo, 2 1/2-T, M36A2	5,000	45	60	56	320	6,000	30	72
Truck, tk, fuel-svc, 1,200-gal, 2 1/2-T, M49A2C	600 gal[3]	45	60	56	300	6,000	30	72

Table 3-1. Truck performance data (continued)

VEHICLE	PAYLOAD (lb)	MAXIMUM GRADE w/Towed Load	MAXIMUM GRADE w/o Towed Load	MAXIMUM SPEED (MPH)	CRUISING RANGE (mi)	TOWED LOAD ALLOWANCE (lb)	FORDING DEPTH w/o Kit (in)	FORDING DEPTH w/Kit (in)
Truck, tk, water-svc, 1,200-gal, 2 1/2-T, 6 x 6, M50A2	400 gal[4]	45	60	56	300	6,000	30	72
Truck, tk, water-svc, 1,200-gal, 2 1/2-T, 6 x 6, M50A3	500 gal	45	60	56	300	6,000	30	72
Truck, dump, 2 1/2-T, 6 x 6, M342A2	5,000	45	60	56	275	6,000	30	72
Truck, van, 2 1/2-T, 6 x 6, M292A1, M292A2, M292A5	5,000	45	60	56	300	6,000	30	72
Truck, trac, 2 1/2-T, 6 x 6, M275A2	7,000[5]	36	60	56	250	17,000[6]	30	72
Truck, van, shop, 2 1/2-T, 6 x 6, M109A3	5,000	45	60	56	300	6,000	30	72
Truck, dump, 5-T, 6 x 6, M51	10,000	47	60	52	488	15,000	30	78
Truck, dump, 5-T, 6 x 6, M51A2	10,000	47	60	54	477	15,000	30	78
Truck, dump, 5-T, 6 x 6, M817	10,000	31	60	52	480	15,000	30	78
Truck, dump, 5-T, 6 x 6 M929, M931	10,000	31	60	55	480	15,000	30	78
Truck, dump, 5-T, 6 x 6, M929A1, M930A1	10,000	31	60	55	500	15,000	32	80
Truck, trac, 5-T, 6 x 6, M52	15,000[5]	28	68	53	300	30,000[6]	30	78
Truck, trac, 5-T, 6 x 6, M52A1	15,000[5]	47	60	54	477	30,000[6]	30	78
Truck, trac, 5-T, 6 x 6, M52A2	15,000[5]	47	60	54	477	37,000[6]	30	78
Truck, trac, 5-T, 6 x 6, M931A1, M931A2	15,000[5,7]	31	51	63	460	37,500[6,7]	32	80

Table 3-1. Truck performance data (continued)

VEHICLE	PAYLOAD (lb)	MAXIMUM GRADE w/Towed Load	MAXIMUM GRADE w/o Towed Load	MAXIMUM SPEED (MPH)	CRUISING RANGE (mi)	TOWED LOAD ALLOWANCE (lb)	FORDING DEPTH w/o Kit (in)	FORDING DEPTH w/Kit (in)
Truck, trac, 5-T, 6 x 6, M818	15,000[5,7]	42	60	52	300	37,500[6,7]	30	78
Truck, trac, 5-T, 6 x 6, M932A1	15,000[5,7]	31	51	63	460	37,500[6,7]	32	80
Truck, cargo, 5-T, 6 x 6, M54	10,000	51	60	53	214	15,000	30	78
Truck, cargo, 5-T, 6 x 6, M54A1, M54A1C	10,000	47	60	54	350	15,000	30	78
Truck, cargo, 5-T, 6 x 6, M54A2, M54A2C	10,000	47	60	54	350	15,000	30	78
Truck, cargo, 5-T 6 x 6, M55A2,	10,000	47	60	54	350	15,000	30	78
Truck,cargo, 5-T, 6 x 6, M55	10,000	46	60	52	225	15,000	30	78
Truck, cargo, 5-T, 6 x 6, M813, M813A1	10,000	55	60	52	350	15,000	30	78
Truck,cargo, 5-T, 6 x 6, M814	10,000	52	60	52	350	15,000	30	78
Truck, cargo, 5-T, 6 x 6, M923, M925	10,000	42	60	55	350	15,000	30	78
Truck, cargo, 5-T, 6 x 6, M923A1, M925A1, M923A2, M925A2	10,000	42	60	63	350	15,000	30	78
Truck, cargo, 5-T, M927, M928	10,000	38	60	55	350	15,000	30	78
Truck, cargo, 5-T, 6 x 6, M927A1, M928A1, M927A2, M928A2	10,000	38	60	63	350	15,000	30	78
Truck, wkr, 5-T, 6 x 6, M62	5,000	36	58	53	214	15,000	30	78
Truck, wkr, 5-T, 6 x 6, M816	7,000	46	60	52	500	20,000	32	78

Table 3-1. Truck performance data (continued)

VEHICLE	PAYLOAD (lb)	MAXIMUM GRADE w/Towed Load	MAXIMUM GRADE w/o Towed Load	MAXIMUM SPEED (MPH)	CRUISING RANGE (mi)	TOWED LOAD ALLOWANCE (lb)	FORDING DEPTH w/o Kit (in)	FORDING DEPTH w/Kit (in)
Truck, wkr, 5-T, 6 x 6, M936A1	7,000	31	60	63	500	20,000	32	78
Truck, wkr, 5-T, 6 x 6, M936A2	7,000	31	60	63	500	20,000	32	78
Truck, van, expansible, 5-T, 6 x 6, M291A1, M291A1C, M291A1D, M291A2C	5,000	—	60	58	350	15,000	30	78
Truck, van, expansible, 5-T, 6 x 6, M820	5,000	52	60	52	350	15,000	—	—
Truck, van, expansible, 5-T, 6 x 6, M934	5,000	41	60	55	350	15,000	30	78
Truck, van, expansible, 5-T, 6 x 6, M934A1	5,000	41	60	63	350	15,000	30	78
Truck, van, expansible, 5-T, 6 x 6, M934A2	5,000	41	60	63	350	15,000	30	78
Truck, stake, 5-T, 6 x 6, M821	10,000	43	60	60	350	15,000	30	78
Truck, cargo, 10-T, 8 x 8, M977	22,000	30	60	57	300	20,000	48	—
Truck, cargo, 10-T, 8 x 8, M978	18,000	30	60	57	300	20,000	48	—
Truck, cargo, 10-T, 8 x 8, M984	31,000	30	60	57	300	20,000	48	—
Truck, cargo, 10-T, 8 x 8, M985	21,729	30	60	57	300	20,000	48	—
Truck, trac, 10-T, 6 x 6, M916	40,000[5]	33	—	59	300	126,000[6]	20	—
Truck, trac, 10-T, 6 x 6, M916A1	68,000[8]	20	—	54	300	130,000[6]	20	—
Truck, trac,10-T, 8 x 6, M920	70,000[5]	28	—	64	300	99,620[6]	24	—

Table 3-1. Truck performance data (continued)

VEHICLE	PAYLOAD (lb)	MAXIMUM GRADE w/Towed Load	MAXIMUM GRADE w/o Towed Load	MAXIMUM SPEED (MPH)	CRUISING RANGE (mi)	TOWED LOAD ALLOWANCE (lb)	FORDING DEPTH w/o Kit (in)	FORDING DEPTH w/Kit (in)
Truck, trac, 10-T, 6 x 6, M123A1C	30,000[5]	47	60	44	350	80,000[6]	78	30
Truck, trac, 14-T, 6 x 4, M915	30,000[5]	41.1	—	65	396	84,000[6]	24	—
Truck, trac, 14-T, 6 x 4, M915A1	28,400[5]	19.9	—	58	357	84,000[6]	20	—
Truck, trac, 14-T, 6 x 4, M915A2	50,000[8]	20	—	56	300	105,000[6]	20	—
Truck, trac, 16.5-T, 10 x 10, PLS, M1074	33,000	30	—	50	225	50,000	48	—
Truck, trac, 16.5-T, 10 x 10, PLS w/crane, M1075	33,000	30	—	50	225	50,000	48	—
Truck, trac, 22 1/2-T, 8 x 6, M911	48,000[5]	20	—	43	300	137,000[6]	28	—
Truck, trac, 22 1/2-T, 8 x 8, M1070	46,000[5]	15	—	45	325	190,400[6]	28	—

[1] Highway requirement only.

[2] Increased loads authorized for several specific S250 shelter payloads.

[3] 1,200-gallon capacity for cross-country authorized by DA waiver, subject to local commander’s discretion.

[4] 1,000-gallon capacity for cross-country authorized by DA waiver, subject to local commander’s discretion.

[5] Vertical loads on the fifth wheel only.

[6] Towed load is the total weight of the semitrailer and payload.

[7] Vehicles approved for use with M871 semitrailer carrying loads up to 44,800 pounds.

[8] Vertical load on tractor.

Table 3-2. Truck performance data – Family of Medium Tactical Vehicles (FMTV)

VEHICLE	PAYLOAD (lb)	MAXIMUM GRADE w/Towed Load	MAXIMUM GRADE w/o Towed Load	MAXIMUM SPEED (MPH)	CRUISING RANGE (mi)	TOWED LOAD ALLOWANCE (lb)	FORDING DEPTH w/o Kit (in)	FORDING DEPTH w/Kit (in)
Truck, cargo, 2 1/2-T, 4 x 4, M1078	5,000	30	60	55	400+	9,520	36	60
Truck, van, 2 1/2-T, 4 x 4, M1079	5,000	30	60	55	400+	9,520	36	60
Truck, cargo, 2 1/2-T, 4 x 4, LAPES, M1081	5,000	30	60	55	400+	9,520	36	60
Truck, cargo, 5-T, 6 x 6, M1083	10,000	30	60	55	300+	21,000	36	60
Truck, cargo w/MHE, 5-T, 6 x 6, M1084	10,000	30	60	55	300+	21,000	36	60
Truck, long, cargo, 5-T, 6 x 6, M1085	10,000	30	60	55	300+	21,000	36	60
Truck, long, cargo, w/MHE, 5-T, 6 x 6, M1086	10,000	30	60	55	300+	21,000	36	60
Truck, van, expansible, 5-T, 6 x 6, M1087	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Truck, trac, 5-T, 6 x 6, M1088	40,000[1]	22	60	55	300+	21,000	36	60
Truck, wkr, 5-T, 6 x 6, M1089	—	22	60	55	300+	21,000	36	60
Truck, dump, 5-T, 6 x 6, M1090	10,000	30	60	55	300+	21,000	36	60
Truck, tk, fuel/water-svc, 1,500/2,000-gal, 6 x 6 M1091	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Truck, cargo, 5-T, 6 x 6, LAPES/AD, M1093	10,000	30	60	55	300+	21,000	36	60
Truck, dump, 5-T, 6 x 6, LAPES, M1094	10,000	30	60	55	300+	21,000	36	60

[1] Vertical load on fifth wheel.

[2] Not available at time of publication.

Step 2: Establish a motor transport schematic (Figure 3-8). The schematic assists the planner by providing a graphical representation of the transportation distribution network.

Step 3: Determine network workload requirements. Determine the total workload throughout the transportation infrastructure and annotate requirements on the transport schematic (which now becomes a workload schematic). The workload schematic (Figure 3-9, page 3-23) depicts commodity by segment and assists the planner in the efficient allocation of resources.

Step 4: Assess the highway tonnage capability. The tonnage capabilities of roads and bridges are important considerations when selecting routes. The gross weight of the heaviest load vehicle should not exceed the rated tonnage capacity of the weakest bridge. It is difficult to determine exact tonnage capabilities of a highway for sustained operations because conditions vary. In the absence of more accurate data, use Table 3-3, page 3-23, as a guide for highway tonnage capabilities. This table gives estimates of supply support tonnage capabilities for various conditions involved with sustained operations. The following steps will enable the planner to assess a highway's capabilities. When more than one condition is involved in a step, apply the most restrictive factor.

- Select the type of road surface.
- Select the area of operation.
- Apply the narrow roadway factor as applicable.
- Apply one of the three limiting terrain factors to the new capability (if applicable). Apply only the most restrictive terrain factor.
- Apply the bad weather factor to the new capability (if weather is expected for a sustained period).
- Determine the workload requirement (convert all commodities to STONs).
- Identify excess or shortfall capacity.

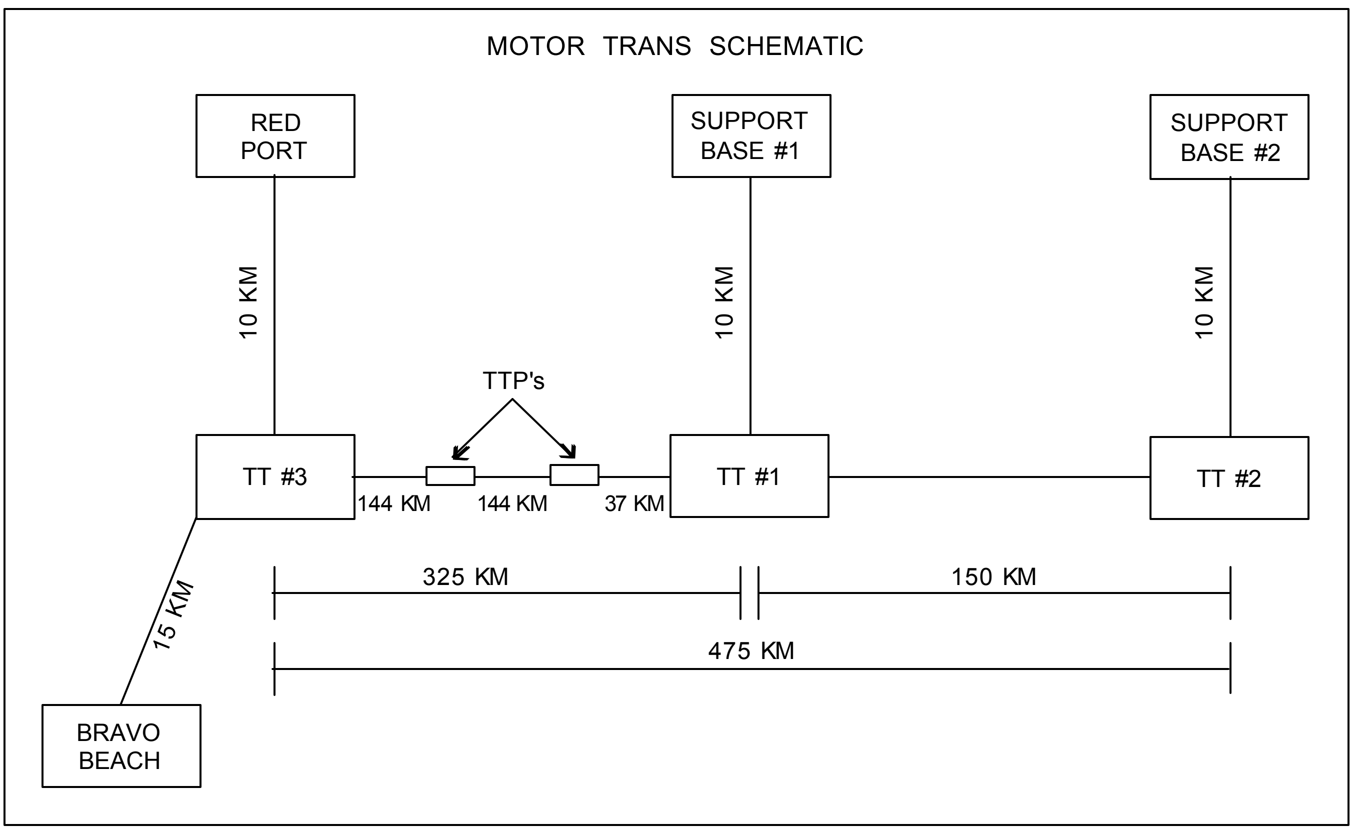


Figure 3-8. Transportation distribution network

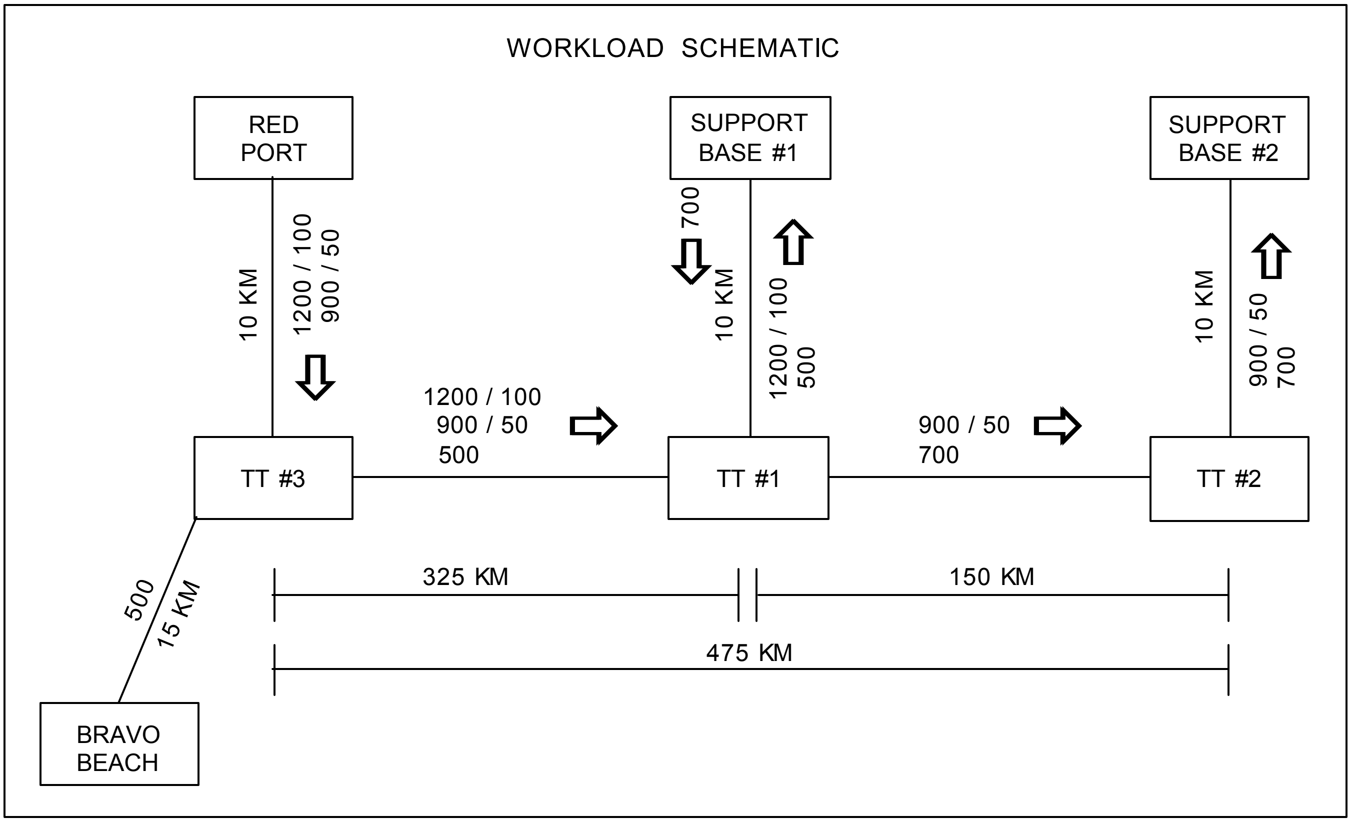


Figure 3-9. Transportation network workload

Table 3-3. Highway tonnage capabilities

HIGHWAY TYPE	DAILY TONNAGE FORWARD (STON s)			REDUCTION FACTORS FOR VARIOUS CONDITIONS (%)				
	Optimum Dispatch (Rear Area)	Supply Traffic (COMMZ)	Supply Traffic (CZ)	Narrow Roadway (Less than 24 ft or 7.20 m)	Rolling Terrain	Hills with Curves	Mountains	Seasonal Bad Weather
Concrete	60,000	36,000	8,400	25	10	30	60	20
Bituminous	45,000	27,000	7,300	25	10	30	60	30
Bituminous-treated	30,000	18,000	5,800	25	20	40	65	40
Gravel	10,150	6,090	3,400	25	20	50	70	60
Dirt	4,900	2,940	1,600	25	25	60	80	90

Step 5: Determine the number of required truck companies. Use Table A-1, page A-9, and Table A-2, page A-12, to determine planning capabilities of the appropriate truck companies. All three units are authorized 60 tractors each (cargo trucks for the light truck company), rendering 50 (60 x 84.7 percent) trucks available for daily tasking and planning purposes. To determine the line-haul and local haul truck company requirements see Figure 3-10. For the types of vehicles used in this exercise, the most restrictive TVAR is used.

LINE-HAUL TRUCK COMPANY REQUIREMENTS

- Line-haul leg between TT #3 and TT #1

Step 1: Segment distance =
(10-1) x 32 KIH = 144 km

Step 2: Number of segments =
325 km = 2.26 = 3 segments 144 km

Step 3: Turnaround time =
2 x 325 km + 3 = 23.31 hr 32 KIH

Step 4: Truck companies required

$$\text{STONs} = \frac{2600 \text{ STONs} \times 23.31 \text{ hr}}{7.02 \text{ STONs} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{60{,}606}{7{,}020} = 8.6$$

$$\text{Contrs} = \frac{150 \text{ contrs} \times 23.31 \text{ hr}}{2 \text{ contrs} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{3{,}495.5}{2{,}000} = 1.7$$

- Line-haul leg between TT #1 and TT #2

Step 1: Segment Distance =

$$\frac{(10 - 1) \times 32 \text{ KIH}}{2} = 144 \text{ km}$$

Step 2: Number of Segments =

$$\frac{150 \text{ km}}{144 \text{ km}} = 1.04 = 1 \text{ segment}$$

Step 3: Turnaround time =

$$\frac{2 \times 150 \text{ km}}{32 \text{ KIH}} + 1 = 10.37 \text{ hr}$$

LOCAL HAUL TRUCK COMPANY REQUIREMENTS

- Local haul network between Port Red and TT #3

Step 1: Turnaround time $= \frac{2 \times 10 \text{ km}}{24 \text{ KIH}} + 2.5 = 3.33$ hr

Step 2: Truck companies required

$$\text{STONs} = \frac{2100 \text{ STONs} \times 3.33 \text{ hr}}{7.02 \text{ STONs} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{6{,}993}{7{,}020} = 1.0$$

$$\text{Contrs} = \frac{150 \text{ contrs} \times 3.33 \text{ hr}}{2 \text{ contrs} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{499.5}{2{,}000} = .25$$

- Local haul network between TT #1 and SB #1

Step 1: Turnaround time $= \frac{2 \times 10 \text{ km}}{24 \text{ KIH}} = 2.5 = 3.33$ hr

Step 2: Truck companies required

$$\text{STONs} = \frac{1700 \text{ STONs} \times 3.33 \text{ hr}}{4.8 \text{ STONs} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{5{,}661}{4{,}800} = 1.2$$

$$\text{Contrs} = \frac{100 \text{ contrs} \times 3.33 \text{ hr}}{1 \text{ STON} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{333}{1{,}000} = .33$$

Step 3: Additional Truck companies required

$$\text{STONs} = \frac{700 \text{ STONs} \times 2.5 \text{ hr}}{4.8 \text{ STONs} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{1{,}750}{4{,}800} = .36$$

- Local haul network between TT #2 and SB #2

Step 1: Turnaround time $= \frac{2 \times 10 \text{ km}}{24 \text{ KIH}} + 2.5 = 3.33$ hr

Step 2: Truck companies required

$$\text{STONs} = \frac{1600 \text{ STONs} \times 3.33 \text{ hr}}{4.8 \text{ STONs} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{5{,}328}{4{,}800} = 1.1$$

$$\text{Contrs} = \frac{50 \text{ contrs} \times 3.33 \text{ hr}}{1 \text{ STON} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{166.5}{1{,}000} = .17$$

- Local haul network between Bravo Beach and TT #1

Step 1: Turnaround time =

$$\frac{2 \times 10 \text{ km}}{16 \text{ KIH}} + 2.5 = 3.75 \text{ hr}$$

Step 2: Truck companies required

$$\text{STONs} = \frac{500 \text{ STONs} \times 3.75 \text{ hr}}{4.8 \text{ STONs} \times 50 \text{ veh} \times 20 \text{ hr}} = \frac{1{,}875}{4{,}800} = .39$$

Figure 3-10. Line-haul and local haul truck company requirements

Step 6: Total truck companies required by TOE type:

- 55727L100 (MED TRK) – 14.26
- 55728L100 (MED TRK) – 3.55

See Table 3-4 for number of truck companies required by segment.

Step 7: Establish command and control structure:

- Total truck companies required: 17.81 = 18
- Total battalions required: 3.6 = 4
- Total groups required: .80 = 1
- TTPs required: 2
- TTP teams required: 10 (3 truck terminals and 2 TTPs x 2 teams per location)

TRANSPORT OPERATIONS

Transport operations support a variety of missions depending on unit locations and situations. Whether in CONUS or overseas, motor transport units are usually employed in a general support role within a specified area or along specific routes. The following paragraphs address various aspects of motor transport operations.

Motor Park Facility

The layout of motor parks varies, depending on space and conditions (Figure 3-11, page 3-26). For new construction, a single structure should be built to economize on construction costs and operating expenses. The typical motor park should include the following facilities:

- Motor park office. This office should be in the motor park operations area.
- Dispatch office. All vehicular operations are controlled through this office. If at all possible, it should be at the exit of the motor park. This allows the dispatcher to visibly check vehicles leaving the parking area.
- Driver's room. For orderly operation, the drivers' room should be near, but separate from, the dispatch office.
- Vehicle washing facilities. These facilities should be available in all weather conditions. They should be located so that drainage flows away from parking areas and buildings. Automatic washing facilities should be considered when feasible.
- Motor pool/shop operations. Activities in the motor pool/shop include regularly scheduled preventive maintenance and services, general repairs, spot painting, minor body work, carpentry, and welding.

Fire hazards and environmental restrictions may require that some functions be performed at other locations. For example, painting and welding must be carried out in separate areas. Mission requirements and vehicle availability determine which work is performed first.

- Parts room. This facility is centrally located within the main shop building to afford easy access to parts and tools. It should include an issue counter, bins, and tool racks.

Table 3-4. Number of truck companies required by segment

	STONs	CONTRS	ADDNL	TOTAL
TT #3 to TT #l line-haul leg	8.6	1.75		10.35
TT #1 to TT #2 line-haul leg	2.4	0.26		2.66
Red Port to TT #3 local haul	1.0	0.25		1.25
TT #l to SB #1 local haul	1.2	0.33	0.36	1.89
TT #2 to SB #2 local haul	1.1	0.17		1.27
Bravo Beach to TT #3 local haul	0.39			0.39
TOTAL	14.69	2.76	0.36	17.81

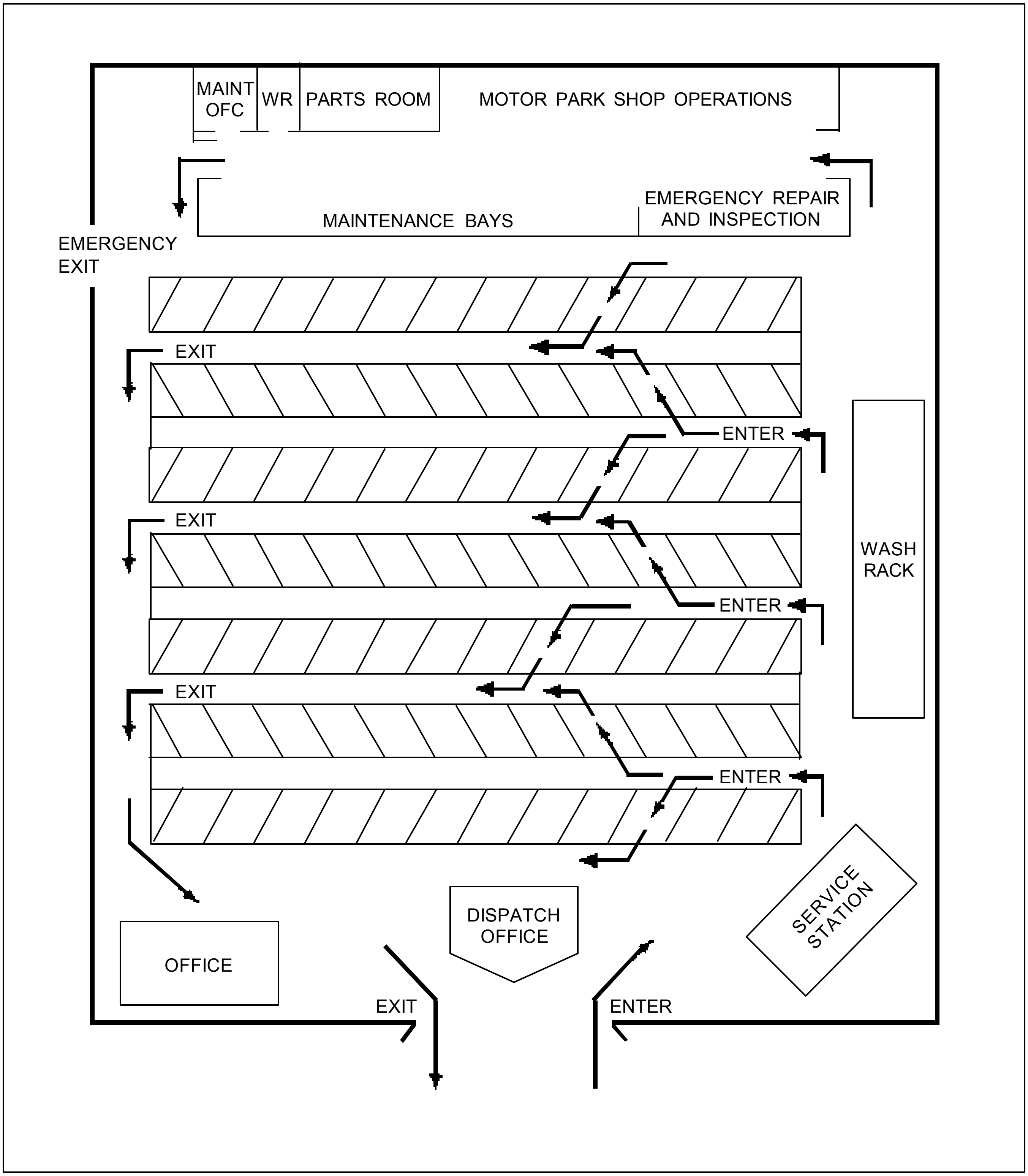


Figure 3-11. Motor park facility layout

Vehicle Loading

The driver is responsible for the proper loading of the vehicle. To begin, place heavy supplies at the bottom of the load, distributing them evenly over the cargo floor. Distributing weight equally ensures that the load will not shift. The following rules also apply to vehicle loading:

- Do not distribute the load loosely or build it too high. High, loosely distributed loads cause swaying, making the vehicle difficult to handle and increasing the danger of overturning or losing cargo. Generally, cargo is not stacked above the top of the side rails.
- If the truck has an open body, put a tarpaulin over the cargo to protect against sun, dust, rain, and pilferage.
- Place barrels and drums on their sides parallel with the length of the truck; brace and pyramid them. If the possibility of leakage prohibits this placement, set the drums upright. Note that fewer drums can be loaded in the same space with the upright arrangement.
- Combine boxed, crated, and packaged cargo with like items or items of compatible shapes or transportability codes.
- Load sacked cargo separately, ensuring that the sacks cannot be punctured by odd-shaped items. Stack sacked cargo in overlapping layers to prevent shifting.

Figure 3-12 shows the right and wrong placements of loads in trucks and semitrailers.

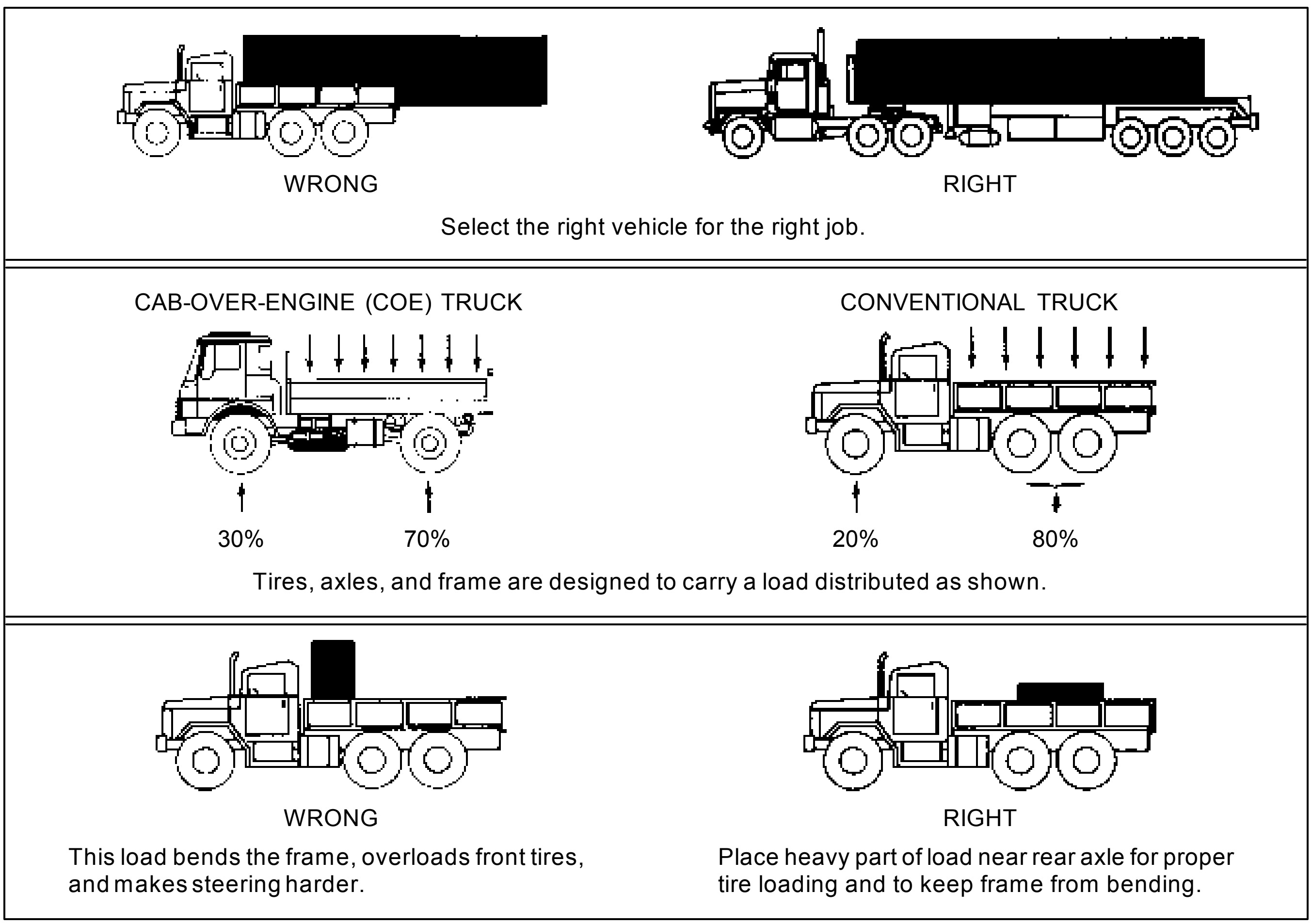
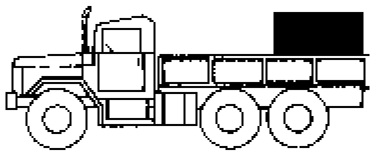
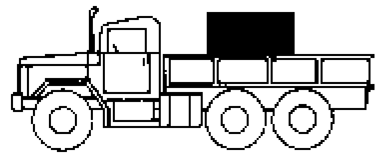


Figure 3-12. Load placement in trucks and semitrailers



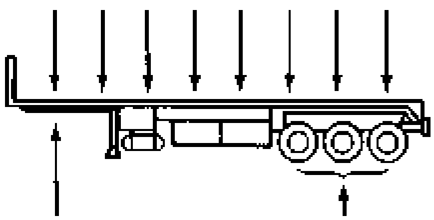
WRONG

This load bends the frame, overloads rear tires, and makes steering almost impossible.

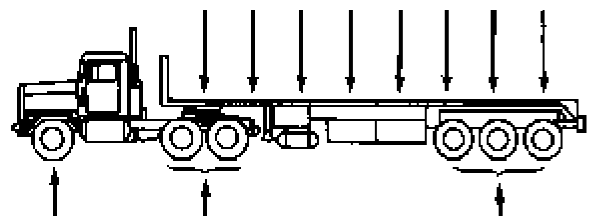


RIGHT

Set a concentrated load just ahead of the rear axle with the longest side on the floor, if possible.

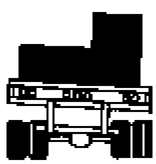


45%   55%



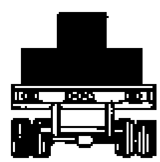
20%   40%   40%

Distribute trailer loads equally between the rear tires and the fifth wheel. This placement transfers the load to the tractor.



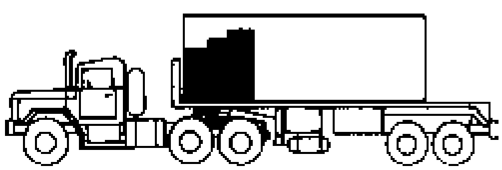
WRONG

This placement overloads one spring and set of tires. Brakes lock on the light side, causing skids.



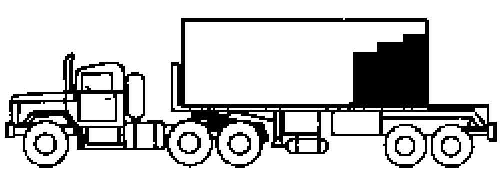
RIGHT

Nothing is overloaded; frame will not twist and loosen cross-member rivets.



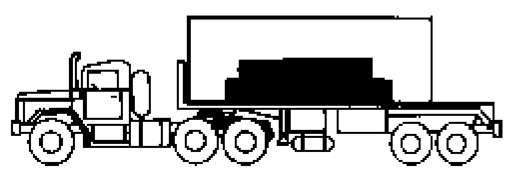
WRONG

This placement shortens tire life and bends the truck rear-axle housing. Applying the trailer brakes may lock the wheels and cause flat spots and skidding.



WRONG

This placement overloads trailer rear wheels so that brakes will not function properly and rubber scuffs away.



RIGHT

Distribute the load over the full trailer floor.

Figure 3-12. Load placement in trucks and semitrailers (continued)

Road Movement Tables

Convoy commanders use road movement tables (Figure 3-13) to track progress during movement. These tables help to ensure that convoys arrive and clear each CP on schedule. They are particularly useful if including such details in the body of the OPORD would complicate it or make it unduly long. Road movement tables often require a wider distribution than normal OPORDs. Copies are issued to convoy operating personnel, movement regulating team personnel, and traffic control posts. For security reasons, tables may not include dates or locations. The road movement table is assigned a security classification based on its contents. The table's classification is not necessarily the same as that of the OPORDs. The road movement table may be issued as an annex to the OPORD. If issued alone the table must be signed and authenticated in the same way as other orders.

The road movement table shows the date of the move, units involved, number of vehicles, and load class of the heaviest vehicle. It also shows the routes and times when serials will arrive at and clear critical points.

(Classification)

Annex B – "Movement Table" to Operation Order for Movement No
Map:

Copy No
Issuing HQ
Place of Issue
Date-Time Group of Signature
Message Reference No

General Data:
1. Average speed:
2. Traffic density:
3. Halts:
4. Routes (between start points and release points):
5. Critical points:
   (a) Start points.
   (b) Release points.
   (c) Other critical points.
6. Main routes to start points:
7. Main routes from release points:

Serial or Movement Number	Date	Unit/ Formation	Number of Vehicles	Load Class of Heaviest Vehicles	From	To	Route	Route to Start Point	Critical Points Ref	Critical Points Due (hr)	Critical Points Clear (hr)	Route from Release Point	Remarks
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)

Authentication:
Appendixes:
Distribution:

(Classification)

Figure 3-13. Suggested format for road movement table

A strip map (Figure 3-14) may also be published as an annex to an OPORD. When a strip map is used, its details should correspond to the data in the road movement table, and it should be distributed to the lowest practical level. Where practical and appropriate, a strip map may include the following data–

- Start point.
- Release point.
- Route numbers.
- Town names.
- Critical points.
- Check points.
- Distance between CPs.
- Total distance.
- North orientation.

Route Reconnaissance

A route reconnaissance overlay (Figure 3-15, page 3-31) is an accurate and concise report of the conditions affecting traffic flow along a specified route. It is the preferred method of preparing a route reconnaissance report. A route or road reconnaissance can be either technical or tactical and is required for both the hasty and deliberate reconnaissance. An overlay and DA Form 1711-R (engineer reconnaissance report) normally satisfy the requirements of hasty route reconnaissance. However, if more detail is required to support the reconnaissance, the overlay is supplemented with written reports describing critical route characteristics in more detail. See Figure 3-16, page 3-32, for an explanation of route reconnaissance overlay symbols.

The following checklist should be reviewed when preparing reconnaissance reports:

- Identification and location of the reconnoitered route.
- Distance between points that should be easily recognized both on the ground and on the map.
- Percent of slope and length of grades that have a 7 percent slope or greater.
- Sharp curves with a radius of 82 feet or less.
- Bridge military load classifications, limiting dimensions, and suitable bypasses.
- Locations and limiting data for fords and ferries.
- Route constrictions, such as underpasses, that are below minimum standard and, if appropriate, the distances these constrictions extend.
- Locations and limiting dimensions of tunnels and suitable bypasses.
- Suitable areas for short halts and bivouacs that offer drive-off facilities, adequate dispersion cover, and concealment.
- Areas of rockfalls and rockslides that may present a traffic hazard.
- Environmentally sensitive or protected areas.

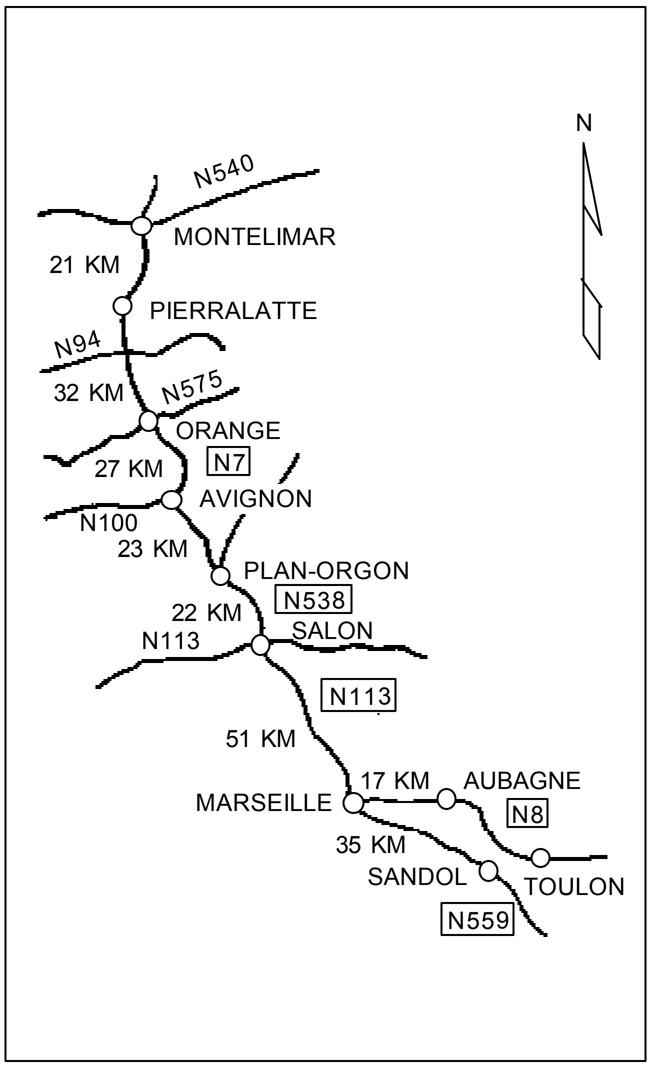


Figure 3-14. Sample strip map

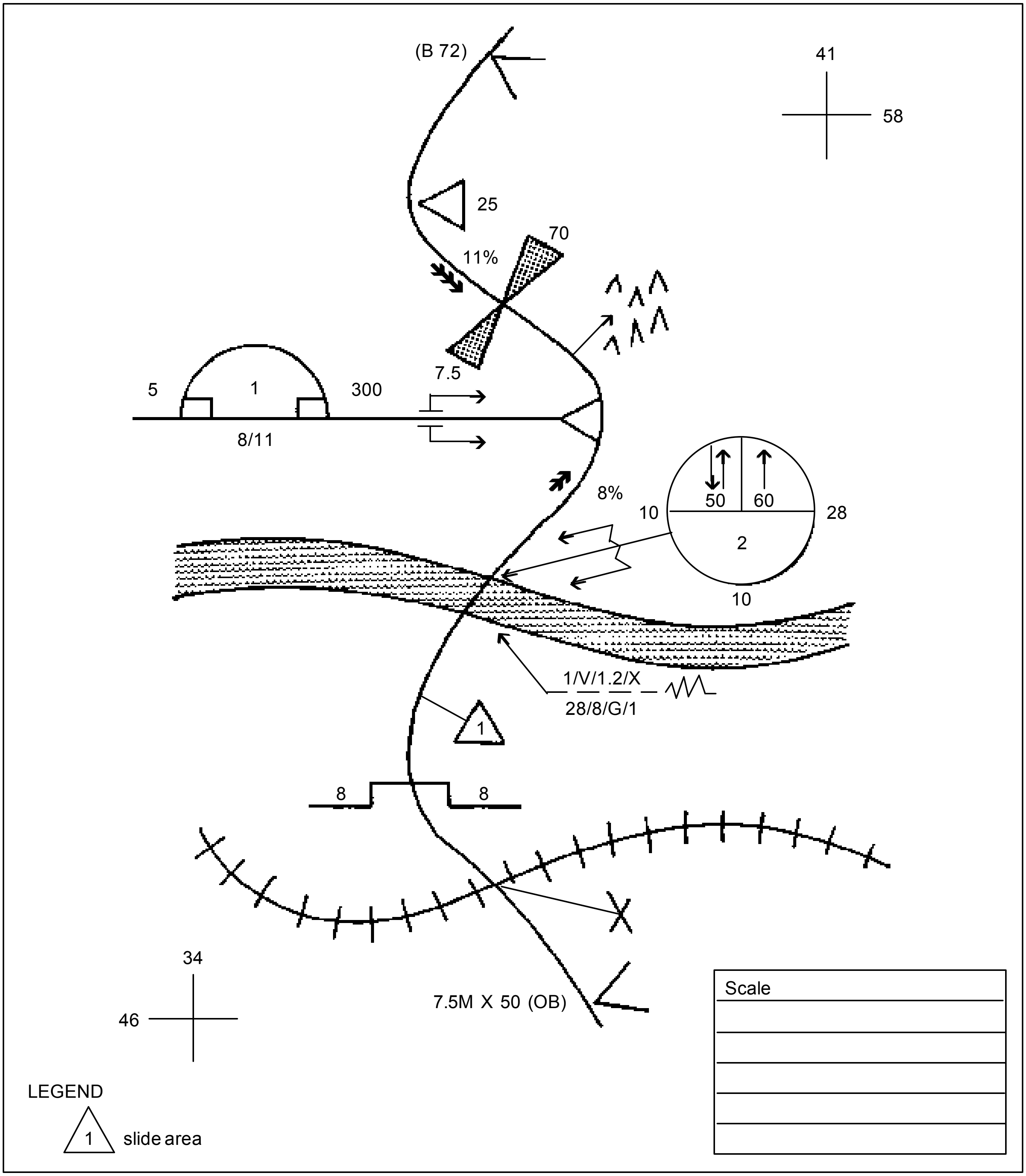


Figure 3-15. Sample route reconnaissance overlay

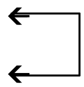
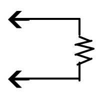
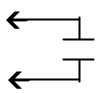
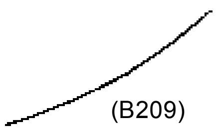
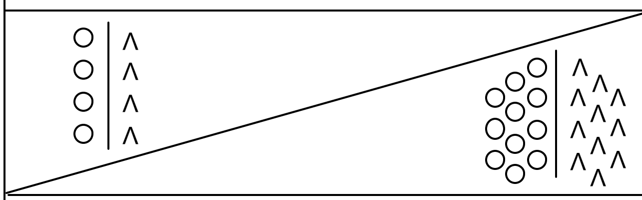
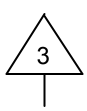
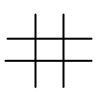
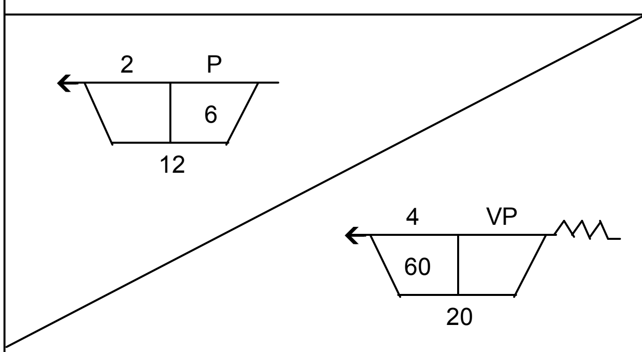
SYMBOL	DESCRIPTION
	Axial route. Use a solid line and identify the route by an odd number.
	Bypass easy. Use when the obstacle can be crossed in the immediate vicinity by a US 2 1/2-ton truck (or NATO equivalent) without work to improve the bypass.
	Bypass difficult. Use when the obstacle can be crossed in the immediate vicinity, but some work to improve the bypass is necessary.
	Bypass impossible. Use when the obstacle can be crossed only by repairing or constructing a feature, or by detouring around the obstacle.
	Civil or military route designation. Write the designation in parentheses along the route. Drawn to scale of map.
	Concealment. Show roads lined with trees by a single line of circles for deciduous trees and a single line of inverted Vs for evergreen trees. Show woods bordering a road by several rows of circles for deciduous trees and several rows of inverted Vs for evergreen trees.
	Critical points. Number, in order, and describe critical points on DA Form 1711-R. Use critical points to show features not adequately covered by other symbols on the overlay.
	Damage or destruction.
	Ferry. Draw arrow to the map location of the ferry. The data above the symbol shows, in order, the left approach, ferry serial number, ferry type, and right approach. The data inside the symbol shows, from left to right, the military load classification and the dead weight capacity in tons. The number below the symbol shows the turn-around time in minutes. A question mark indicates unknown information. Difficult approaches are shown by a straight line. Ferry type – V = vehicular, P = pedestrian

Figure 3-16. Route reconnaissance symbols

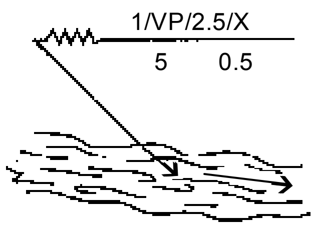
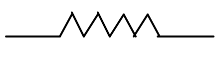
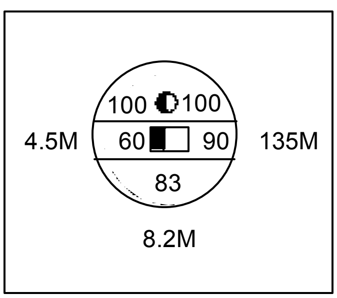
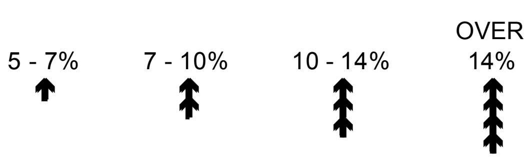
SYMBOL	DESCRIPTION
	Ford. Draw arrow to the ford location. The data above the line shows, in order, the left bank approach, the ford serial number, ford type, stream velocity (in meters per second), seasonal limitations, and right bank approach. The left and right banks are determined by looking downstream. The data below the line shows, in order, length, width, bottom type, and depth. All measurements are in meters. Question marks indicate unknown information. Ford type – V = vehicular, P = pedestrian Seasonal limiting factors – X = no seasonal limitations except for limited duration after sudden flooding. Y = significant seasonal limitations. Bottom type – M = mud C = clay S = sand G = gravel R = rock P = artificial paving
	Approach conditions – Difficult Easy
	Full NATO bridge symbol. Indicate wheeled vehicles in the upper third of the symbol with the two-way wheeled classification at the left and the one-way wheeled classification at the right. Show tracked vehicles in the center third of the symbol with the two-way tracked classification at the left and the one-way tracked classification at the right. Place the bridge serial number in the lower third of the symbol. Draw the arrow to the location of the bridge and show bypass conditions on the arrow shaft. Place traveled way width below the symbol, overhead clearance to the left of the symbol, and overall length to the right of the symbol.
	Grades. Show the actual percent of grade. Any grade of 7 percent or more is an obstruction and is included in the route classification formula. Arrows point uphill, and the length of the arrow represents the length of grade if the map scale permits.
— — — — — — 32	Lateral route. Use a broken line and identify the route by an even number.

Figure 3-16. Route reconnaissance symbols (continued)

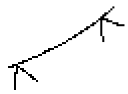
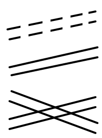
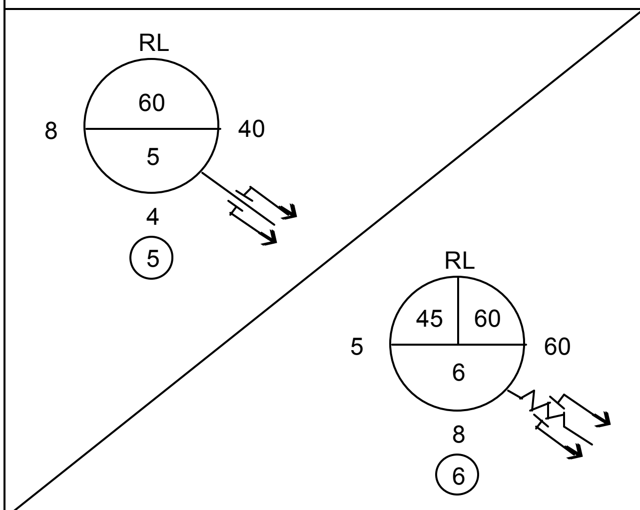
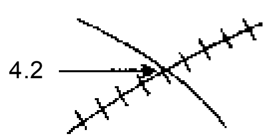
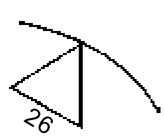
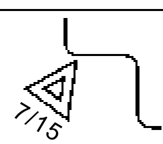
SYMBOL	DESCRIPTION
	Limits of sector. Show the beginning and ending of the reconnoitered section of a route or road with this symbol.
	Obstacles. Place the center of the symbol over the location of the blocked part of the route. Use parallel broken lines for a proposed block, parallel lines for a prepared but passable block, and crossed lines for a completed block.
	Overhead clearance unlimited.
	Parking area.
	Railway bridge symbol. Place RL above the symbol to indicate a railway bridge. At the left of the symbol, show the overhead clearance. Show the overall length of the bridge at the right of the symbol. Indicate the traveled way width below the symbol and underline it if it is below standard for the classification. Inside the symbol, show the bridge classification in the upper half. If the class is different for single- and double-flow traffic, show single-flow on the left and double-flow on the right. Place the railway bridge serial number in the lower half of the symbol. Draw an arrow to the map location of the bridge. On the arrow shaft, indicate the ease of adapting the bridge for road vehicle use. A zigzag line means it would be difficult to adapt, and a straight line means it would be easy to adapt. Place the bypass symbol on the arrow shaft to indicate bypass conditions.
	Railroad grade crossing. Use this symbol to show a level crossing where passing trains would interrupt traffic flow. If there is a power line present, show its height, in meters, from the ground. Underline the overhead clearance if it is less than 4.3 meters.
	Sharp curve. Point the vertex of triangle to map location of curve and indicate the radius of the curve, in meters, outside the triangle. A curve of 45 meters or less must be reported on the overlay, and a curve of 25 meters or less is an obstruction.
 -45m or less to need recording -25m or less to be (c=3)	Series of sharp curves. Point the vertex of the triangle at the first curve in the series. Indicate the number of curves in the series (left) and the radius of the sharpest curve (right).

Figure 3-16. Route reconnaissance symbols (continued)

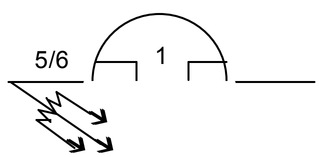
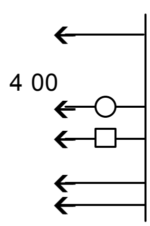
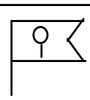
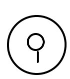
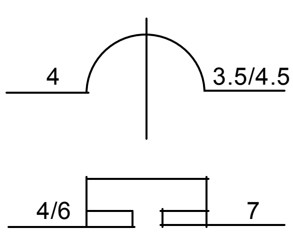
SYMBOL	DESCRIPTION
10.5 m/X/120/00 6 m/Z/30/4.1 m/(OB) 9 m/V/40/5 m/(OB) (W)	Routes classification formula. Express the formula in the order of route width, route type, military load classification, minimum overhead clearance, obstructions, if present, and special conditions. Route types – X = all-weather route Y = limited all-weather route A = fair-weather route Special conditions (T) = regular snow blockage (W) = regular flooding
	Tunnel. Draw arrow to map location of tunnel. Place bypass condition symbol on arrow. Show minimum and maximum overhead clearances to the left of the symbol, the tunnel serial number inside the symbol, and the total tunnel length to the right of the symbol. Below the symbol, show the traveled way width. If sidewalks are present, follow with a slash and the total traveled way, including sidewalks. Underline the traveled way if the road entering the tunnel is wider than the traveled way of the tunnel. Use a question mark to show unknown information.
	Turnout. Use this symbol to show the possibility of driving off the road. Draw the arrow in the direction of the turnout (right or left of road). For wheeled vehicles, draw a small circle on the shaft of the arrow. For tracked vehicles, draw a small square on the shaft of the arrow and place the length of the turnout, in meters, at the tip of the arrow. When a turnout is longer than 1 kilometer, use double arrows.
	Traffic control headquarters.
	Traffic control post.
	Underpass constrictions. Draw the symbol over the road. Place the width of the traveled way, in meters, to the left of the symbol. If sidewalks are present, follow the traveled way width with a slash and the total width, including sidewalks. Underline the traveled way width if the road entering the underpass if wider than the underpass traveled way. Show the overhead clearance, in meters, to the right of the symbol. Show both minimum and maximum overhead clearances, if different.

Figure 3-16. Route reconnaissance symbols (continued)

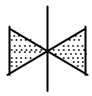
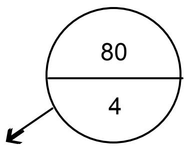
SYMBOL	DESCRIPTION
?	Unknown or doubtful information.
4  120	Width constriction. The number at the left shows the narrowest width of the constriction, and the one at the right is the total constricted length. Both dimensions are in meters.
	Bridge. Arrow extends to the bridge's location on the map. Lower portion of symbol indicates the bridge serial number; the upper portion indicates military load classification. Classification numbers must be underlined if width or overhead clearance is below minimum standard.

Figure 3-16. Route reconnaissance symbols (continued)

Traffic Circulation Plan

A traffic circulation plan (Figure 3-17, page 3-37) is a map overlay or graphic representation that shows a road net and gives necessary information and traffic restrictions. The circulation plan establishes one-way, two-way, and alternating routes of traffic flow. Routes must be available for a circular flow in the required directions. A one-way route normally requires a return route in the opposite direction. Adequate access and egress routes must be provided to prevent congestion of MSRs. The traffic circulation plan includes–

- All MSRs, checkpoints, and highway regulation points.
- Route names, direction of travel, boundaries, and principal supply activities.
- Any restrictive route features, critical points, and rest and refuel areas.
- Traffic control points if provided by the provost marshal before publication.

Traffic circulation plans frequently combine a standard map with an overlay to give the needed information. If the necessary information is too much to put on one overlay, use separate overlays for different types of information.

Tonnage capacities of roads and bridges are important considerations when selecting routes. The gross weight of the heaviest loaded vehicle should not exceed the rated tonnage capacity of the weakest bridge. It is difficult to determine exact tonnage capabilities of highways for sustained operations because conditions will vary. Also, the volume of tactical, administrative, and local traffic using supply routes may exceed that of cargo-hauling vehicles. This traffic further restricts highway transport capabilities.

In the absence of more accurate data, refer back to Table 3-3, page 3-23, as a guide for highway tonnage capabilities. This table gives estimates of supply support tonnage capabilities for various conditions. Sustained operations, adequate road maintenance, and two-way traffic are assumed. When more than one limiting condition is involved, apply the reduction factors in the same order as they appear in the table (left to right):

- First, narrow roadway.
- Second, terrain (rolling hills or mountains).
- Third, weather (if conditions are sustained).

Size and weight limits change periodically as a result of road and bridge construction. Planners must verify local limits and clearance and exemption methods with local military or civilian agencies before putting vehicles on the road.

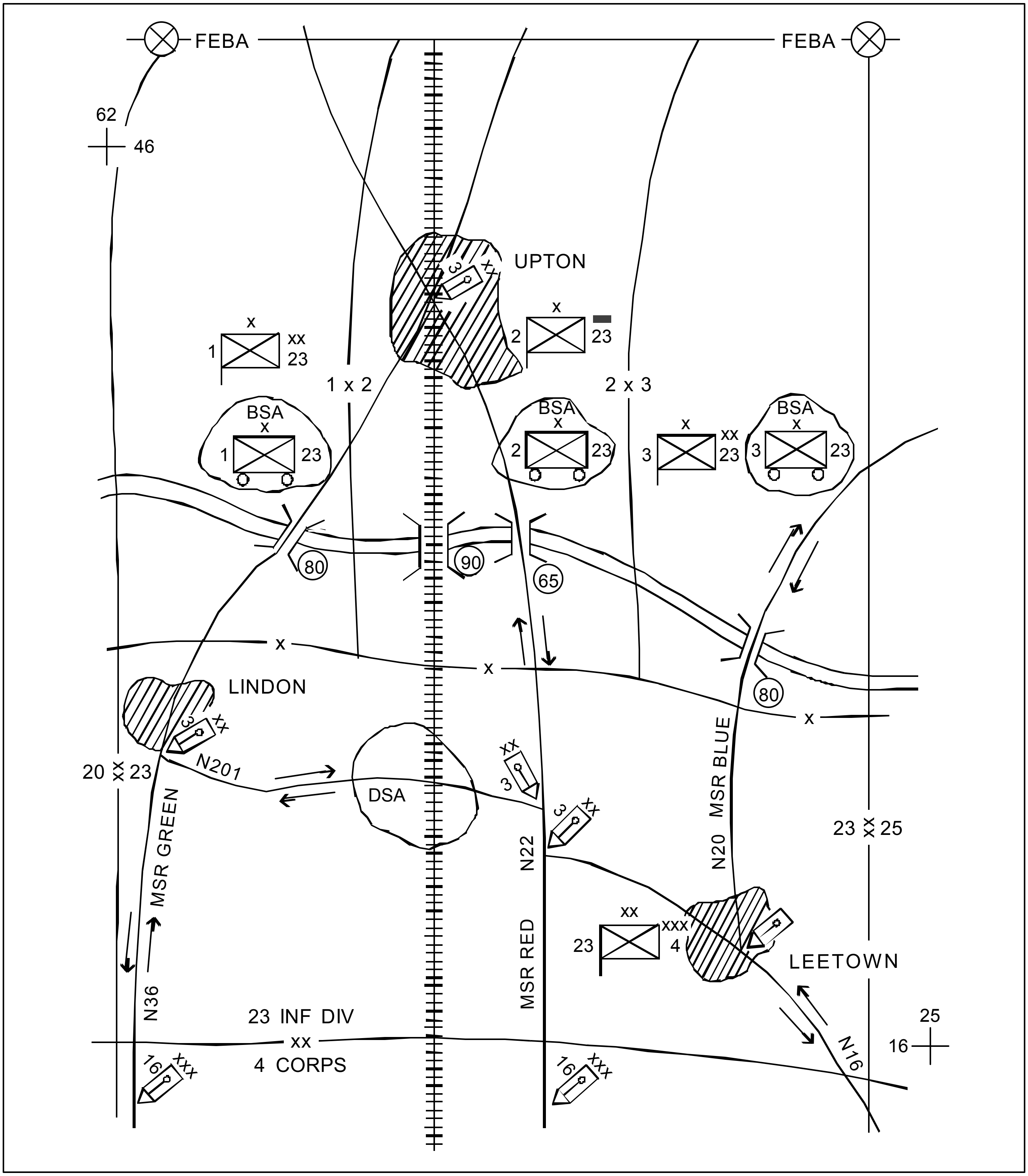


Figure 3-17. Sample traffic circulation plan

Military Load Classification System

The military load classification system is a load-capacity rating system based on vehicle weight and its effect on routes and bridges. In this classification system, whole numbers are assigned to vehicles, bridges, and routes. Most allied military vehicles are externally marked with their respective classification number. Military load classifications are assigned to bridges and routes based on their safe-load capacity and physical dimensions. See FM 5-36 for a detailed discussion of the military load classification system.

Vehicles. Except for prime movers, self-propelled vehicles in Class 3 or higher and towed vehicles in Class 1 or higher are marked to indicate their class. Prime movers are marked either with their own class or the class of the normal combination of prime mover with trailer or semitrailer. Markings on trucks should be on the right front, on or above the bumper, and below the driver's vision. Markings are lusterless black numerals on a lusterless forest green background. See Figure 3-18 for examples of truck markings. See FM 5-170 for weight classification listings of specific vehicles.

Bridges. Every military bridge is posted with a number capacity to indicate the highest weight-class vehicle that can safely cross. Heavier vehicles are barred except in special cases; for example, crossing at reduced speed or in limited numbers. Fixed bridges may also be marked with the length in feet of the span which corresponds to the posted capacity.

There are two types of bridge signs: classification (circular) signs and information (rectangular) signs. In both types, symbols or letters appear in black on a yellow background. See Figure 3-19, page 3-39, and Figure 3-20, page 3-40, for examples.

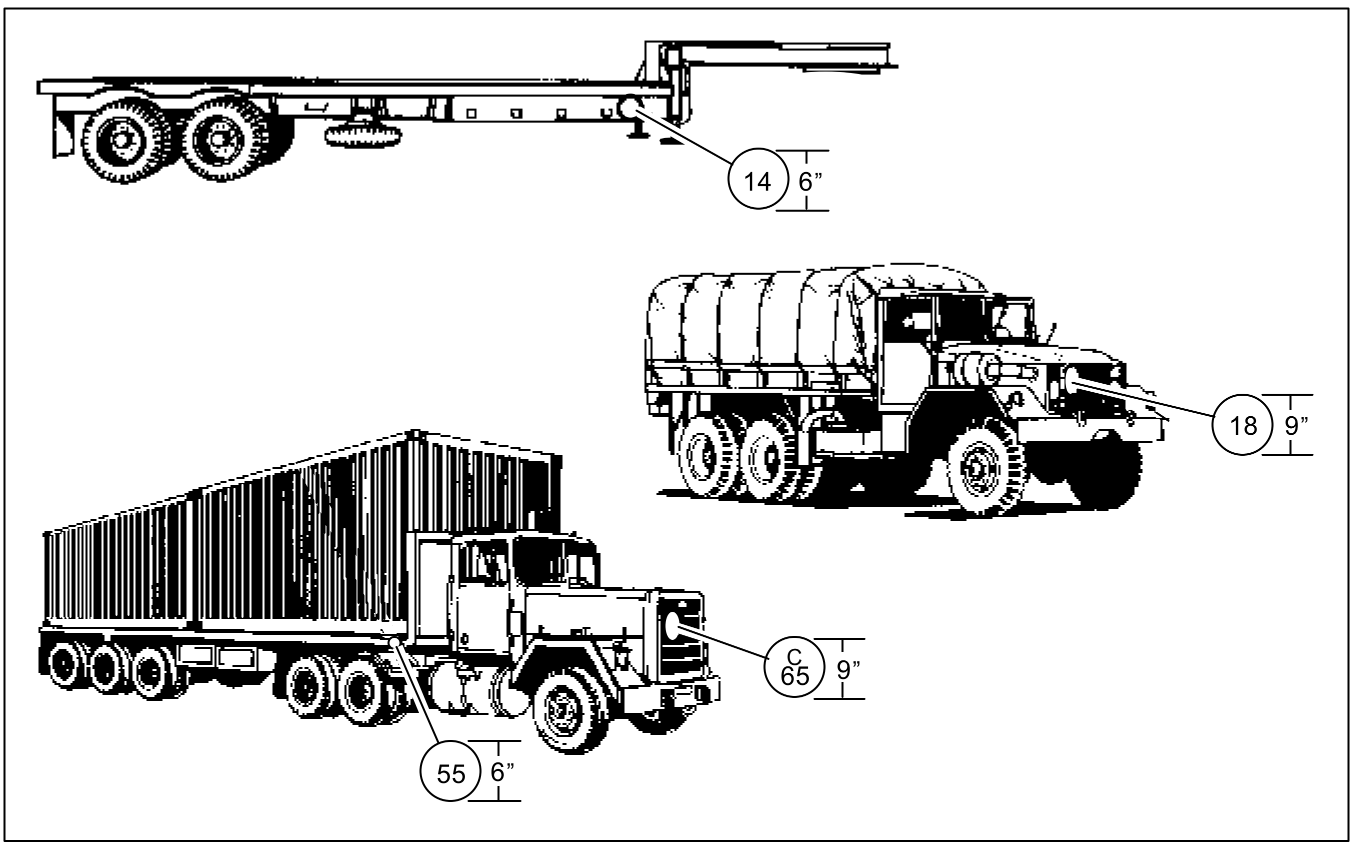


Figure 3-18. Vehicle classification markings

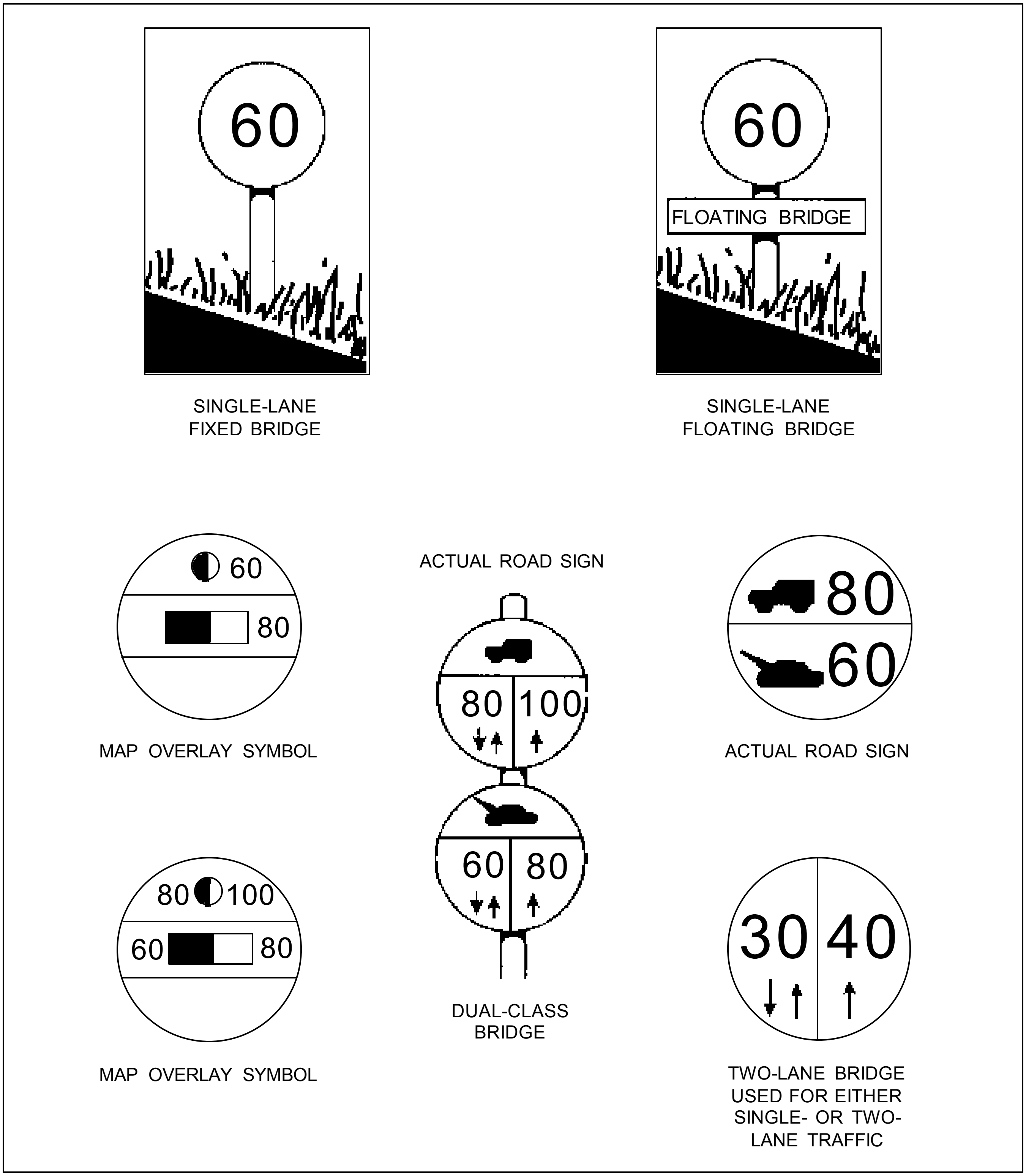


Figure 3-19. Typical bridge signs

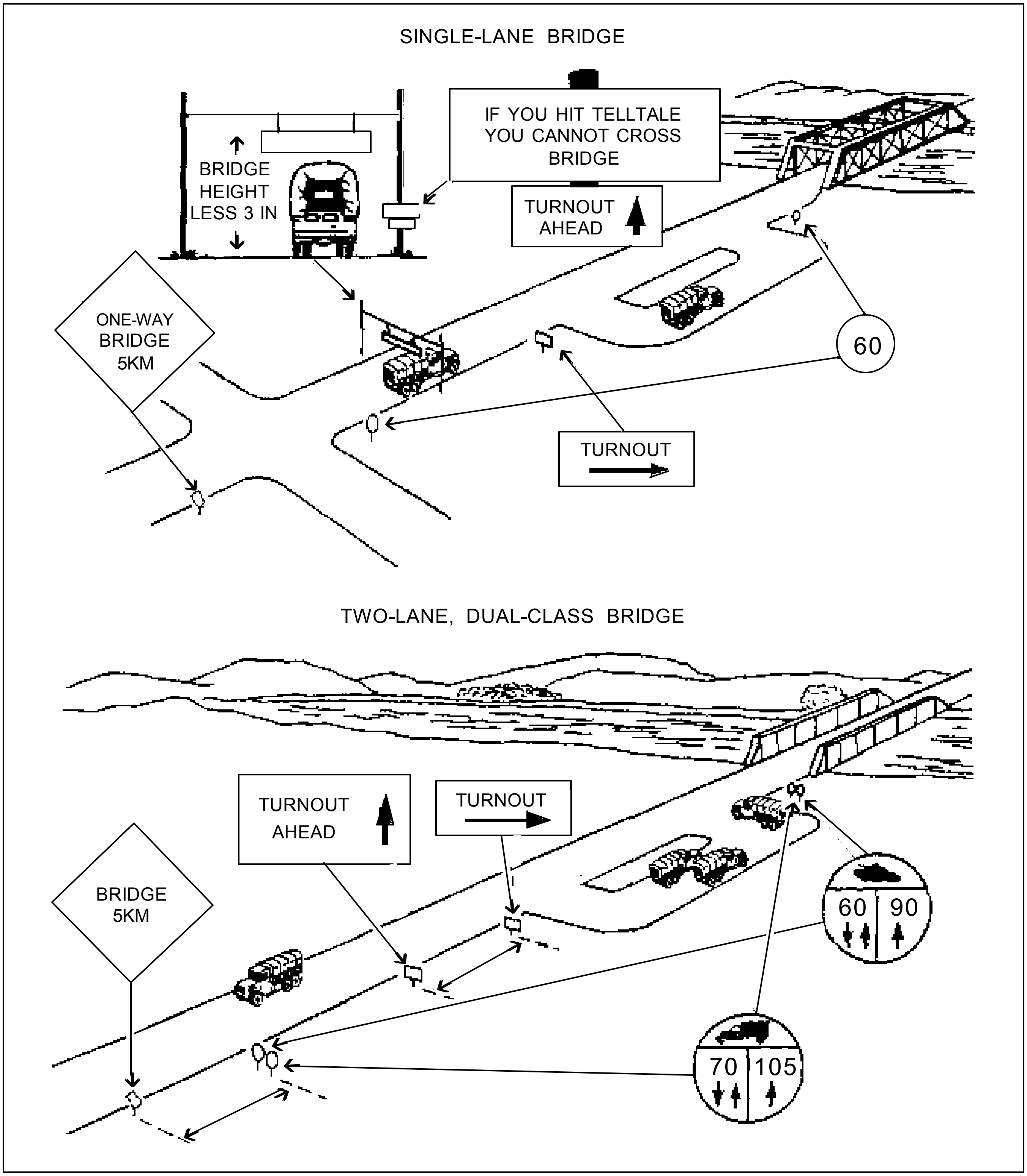


Figure 3-20. Typical placement of bridge signs

Routes. Routes are classified according to the route classification formula. The formula is a brief description of the route that is used with a route reconnaissance overlay. The route classification formula reflects the following:

- Route width.
- Route type.
- Lowest military load classification.
- Obstructions, if any, to traffic flow.
- Overhead clearance.
- Special conditions on the route.

The width of a route, including bridges, tunnels, roads, and other constrictions, is the narrowest width of the traveled way and is expressed in meters or feet. Minimum route widths for wheeled and tracked vehicles in single- and double-flow traffic are shown in Table 3-5.

Type. For classification purposes, the type of route is based on its resistance to the effects of weather. The worst section of the route determines its type. Route types are defined as follows:

- Type X – an all-weather route that, with reasonable maintenance, is passable throughout the year to maximum capacity traffic. Roads on a Type X route normally have waterproof surfaces and are only slightly affected by precipitation and temperature fluctuations. At no time is the route closed to traffic due to weather except for temporary snow or flood blockage.
- Type Y – an all-weather route which, with reasonable maintenance, can be kept open in all weather, although sometimes it is open to less than maximum capacity traffic. Roads on a Type Y route usually do not have waterproof surfaces and are considerably affected by precipitation and temperature fluctuations. Adverse weather conditions may cause traffic to be completely halted for short periods of up to one day at a time, during which heavy use of the road may cause complete collapse of the surface.
- Type Z – a fair-weather route which quickly becomes impassable in adverse weather and can then be kept open only by major repairs/construction. A Type Z route is so seriously affected by weather that traffic may be brought to a halt for long periods.

Table 3-5. Minimum route widths for wheeled and tracked vehicles

TRAFFIC FLOW	WIDTHS	
	Wheeled Vehicles	Tracked Vehicles
Single	18 to 24 ft (5.5 to 7.3 m)	19.5 to 26 ft (6 to 8 m)
Double	Over 24 ft (7.3 m)	Over 26 ft (8 m)

Load. Route load classification is usually determined by the lowest bridge or ferry military load number (regardless of vehicle type or traffic conditions). Using the lowest bridge classification number ensures that the route will not be overloaded. When a proposed route has a military load classification lower than that of the vehicles that must cross it, this fact is shown on the route reconnaissance overlay. A special reconnaissance determines if a change in traffic control procedures, such as a single-flow crossing, would make the route safe for these vehicles. If there is no bridge on the route, the worst section of road governs the route classification.

Obstructions. Obstructions affect the type, amount, and speed of traffic flow. Route obstructions are indicated in the route classification formula by the letters "OB." (An exception is bridge capacities reported separately as a military load classification.) Reconnaissance overlay symbols are used to describe the nature of each obstruction on the overlay. The following obstructions must be reported:

- Overhead obstructions, such as bridges, tunnels, underpasses, wires, and overhanging buildings, that have an overhead clearance under 14 feet (4.3 m).
- Reductions in traveled-way widths which are below the standard minimums prescribed in FM 5-170 for the type of traffic flow. Examples are width reduction due to bridges, tunnels, craters, lanes through mine areas, and projecting buildings or rubble.
- Gradients (slopes) of 7 percent or greater.

- Curves with radius of less than 82 feet (25 meters).
- Ferries.
- Fords.

NOTE: Slopes of 5 percent or more and curves of 45 meters or less must be reported on the reconnaissance overlay (even though they do not meet the obstruction criteria) to ensure that minimal trafficability requirements are reported.

If an obstruction appears in the route classification formula, refer to the route reconnaissance overlay to determine the exact type and location of the obstruction.

Formulas. Examples of typical route classification formulas are shown in Table 3-6.

Convoy Movement

A convoy is a group of vehicles moving from the same origin to destination that are organized under a single commander for the purpose of control. All vehicles normally move at the same march rate. The number of vehicles that make up a convoy will be determined by theater policy, standardization agreements, or host nation traffic regulations. In the absence of policies to the contrary, convoys should consist of six or more vehicles. Also, when 10 or more vehicles per hour are dispatched to the same destination over the same route, they will be considered a convoy.

To aid in control, large columns may be broken down into serials, and serials may be broken down into march units. Each column and each organized element must include the following personnel:

- Commander, either officer or noncommissioned officer, whose place in the column varies to best control the convoy.
- Pacesetter, in the first vehicle of the first element, to lead the column and regulate its speed.
- Trail officer, in each column, travels in the rear of each element to deal with problems that occur within the column.

Table 3-6. Typical route classification formulas

FORMULA	MINIMUM WIDTH OF TRAVELED WAY	ROUTE TYPE	MILITARY LOAD CLASSIFICATION	REMARKS
20 ft Z 10	20 ft	fair weather	10	Based on 20-ft min width of travled way, accommodates wheeled and tracked, single-flow traffic. No obstructions.
20 ft Z 10 (OB)	20 ft	fair weather	10	If used for double-flow traffic, min width of traveled way (20 ft) is considered an obstruction.
7 M Y 50 (OB)	7 M	limited all weather	50	If used for wheeled or tracked vehicles in double-flow traffic, min width of traveled way (7M) is considered an obstruction.
10.5 M X 120 (OB)	10.5 M	all-weather	120	Based on 10.5-m min width of traveled way, accommodates wheeled and tracked vehicles in double-flow traffic.

Column identification. Each column is identified according to STANAG 2027 guidance. For example, a blue flag on the lead vehicle, a green flag on the last vehicle. When moving at night the lead vehicle also shows a blue light and the last vehicle a green light. The column commander's vehicle displays a flag bisected by a diagonal line to form two triangles. The upper triangle is white; the lower is black. In areas where vehicles drive on the left side of the roadway, flags are mounted on the right side of the vehicle; otherwise, they are mounted on the left side.

Each column is identified for the entire movement by a number known as a "movement number" or "identification serial number." The controlling and scheduling movement control organization assigns this number at the time it assigns the movement credit. Command directives or STANAGs normally prescribe that moving units chalk the movement credit on the sides of their vehicles and, if possible, in the front of their vehicles to identify that the movement is authorized. In Europe, the movement number includes a date, organizing authority, and sequence number, as follows:

- Two digits indicating the day of the month when movement is scheduled.
- Three or four letters indicating the organizing authority. First two letters are the national symbols shown in STANAG 1059.
- Two or three digits indicating the serial number assigned by the responsible authority; one letter to identify elements of the column (optional).

For example, movement number 15-JSV-412D identifies column number 8, composed of V Corps vehicles, which will be moved by US authority on the third day of the current month. The elements of a convoy may be identified by adding a letter behind the movement number. Based on circumstances, columns may also be identified IAW theater policy, HN guidance, or other STANAGs.

In CONUS, movement numbers normally include a command identifier, Julian date, and sequence number. For example, a unit from Fort Bragg, NC will move on Julian date 010, and the credit was the first issued for that date. The movement credit would be FB-010-01. Codes may be added after the sequence number to further identify the unit or type of movement. See FM 55-10 for more information.

NOTE: Command directives will determine the makeup of movement numbers in any theater not governed by a STANAG. For a description of how to develop a movement number in CONUS, see FM 55-312.

Movement credit. A movement credit is an allocation granted to one or more vehicles in order to move over a controlled route in a fixed time according to movement instructions. Besides the allocation of a movement number or identification serial number, a movement credit indicates times at which the first and last vehicle of a column are scheduled to pass the entry and exit points. These are the points where the column enters and leaves the controlled route. The credit is a control number. Policies for determining the codes used for movement credits are governed by STANAGs, HN traffic regulations, or command directives.

Preparing for Vehicle Air Movement

Units which must be ready for immediate air movement should make preparations well in advance to avoid delays in loading vehicles on transporting aircraft. Essential items of information which should be known beforehand for each vehicle are–

- Weight with load.
- Dimensions.
- Center of balance.
- Prepared hazardous materials (IAW TM 38-250).

Weight and dimensions. The weight and dimensions of almost all Army equipment can be found in TB 55-46-1. If this publication is not available but a scale is, weigh the item. If an item of equipment is too big to manhandle onto a scale, load it on a vehicle and weigh it on a vehicle scale. Make sure that scales are calibrated.

Center of balance. The CB of cargo items must be determined before the weight and balance of a loaded aircraft can be computed. The shipping agency is responsible for marking each item of cargo with the correct gross weight and a CB point. Mark all items measuring 10 feet or longer and those having a balance point other than at center. Mark vehicles with load-carrying capability to show an empty or loaded CB, whichever is appropriate. Items not marked according to these guidelines will not be accepted for airlift.

The weight and CB of a vehicle is determined after all secondary loads are secured. Secondary loads are items of baggage or cargo transported in truck beds and trailers that must be included in total vehicle weight. Nothing can be added to or removed from a vehicle that has been weighed without afterwards reweighing the vehicle.

Terms used in measuring and weighing vehicles include:

- RDL – reference datum line. Predetermined point from which all measurements are taken.
- FOH – front overhang. Distance in inches from front bumper to center of front axle.
- WB – wheelbase. Distance in inches from center of front axle to center of rear axle or center of tandem axles.
- ROH – rear overhang. Distance from rear or center of tandem axles to rear bumper.
- FAW – front axle weight in pounds.
- RAW – rear axle weight in pounds.
- MOMENT – the product obtained by multiplying the weight at a given point by its distance in inches from the RDL.

To compute the CB of a vehicle, multiply the weight of each axle by its distance from the RDL. The result is called the moment. Next divide the moment by the gross weight of the vehicle. The resulting CB figure is the number of inches measured aft from the RDL to the point where the vehicle will balance. Compute CB to the nearest whole inch.

$$\frac{(W_1 \times D_1) + (W_2 \times D_2)}{\text{gross weight}} = CB$$

where W_1 = front axle weight
W_2 = rear axle weight
D_1 = distance from RDL to front axle
D_2 = distance from RDL to rear axle

See Figure 3-21 for illustrations of weight and measurement points.

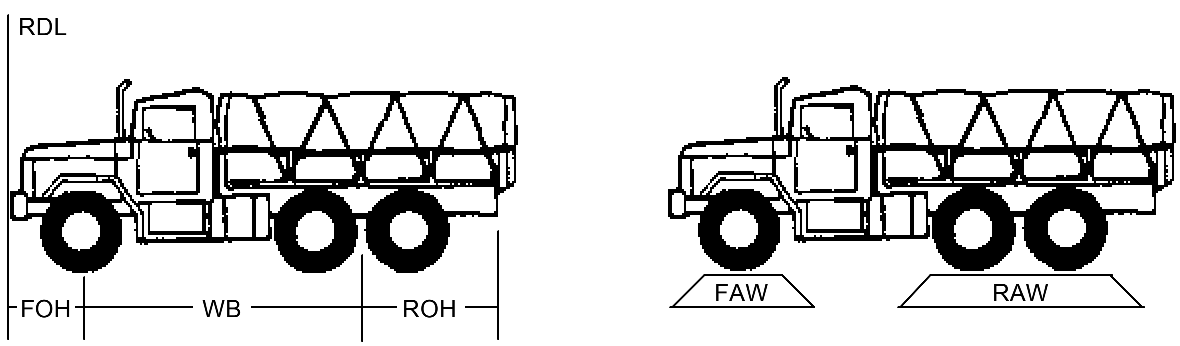


Figure 3-21. Weight and measurement points

After computing CB, mark both sides of the vehicle with masking tape to form a "T" shape. Use a grease pencil or magic marker to write the gross weight in the crossbar of the "T." Write the letters "CB" in the vertical bar to mark exact CB position. Mark axle weights above each axle. See Figure 3-22, page 3-46, for an example of a CB marker. The following examples illustrate methods to determine weight and CB of typical cargo. The examples include single-axle, multiaxle, and tracked vehicles and skid-mounted cargo.

Example 1 – vehicles:

Step 1. Determine front and rear axle weights.

Step 2. Determine distance from front and rear axles to the RDL.

Step 3. Enter the weights and distances into the CB formula:

$$\frac{(5{,}000 \times 60) + (10{,}000 \times 180)}{15{,}000} = \frac{300{,}000 + 1{,}800{,}000}{15{,}000}$$

Step 4. Divide the total moment by the gross weight.

$$= \frac{2{,}100{,}000}{15{,}000} = 140 \text{ inches}$$

The CB of the vehicle measured from the front end (RDL) is 140 inches.

Example 2 – trailers:

When using the formula to compute CB of a trailer, consider the tongue to be the front axle; consider the actual axle to be the rear axle.

Step 1. Weigh tongue and axle.

Step 2. Measure the distance from the end of the tongue to the center of the axle.

Step 3. Enter the weights and distances into the formula.

$$\frac{(150 \times 1) + (3{,}600 \times 80)}{3{,}750} =$$

$$\frac{150 + 288{,}000}{3{,}750} = \frac{288{,}150}{3{,}750} = 76.84$$

The CB of the trailer measured from the tongue (RDL) is 77 inches.

Example 3 – multiaxle vehicles:

Step 1. Determine all axle weights.

Step 2. Determine distance from each axle to the RDL.

Step 3. Enter the weights and distances into the formula.

$$\frac{(10{,}000 \times 42) + (13{,}600 \times 209) + (11{,}200 \times 463)}{34{,}800} =$$

$$\frac{420{,}000 + 2{,}842{,}000 + 5{,}185{,}600}{34{,}800} = \frac{8{,}448{,}000}{34{,}800}$$

Step 4. Divide the total moment by the gross weight.

$$\frac{8{,}448{,}000}{34{,}800} = 243 \text{ inches}$$

The CB of the vehicle measured from the front end (RDL) is 243 inches.

Example 4 – tracked vehicles:

Step 1. Weigh the vehicle on a platform scale (truck scale, coal yard scale) large enough to accommodate the entire vehicle. Record weight.

Step 2. Drive the vehicle onto a wooden beam or pole until the vehicle tilts forward. Mark the CB and gross weight on the side of the vehicle at the point of tilt.

Example 5 – skid-mounted cargo:

Step 1. If the skid-mounted cargo will fit on the scale, weigh the whole load.

Step 2. Place the load on a pipe and center it until it balances. Mark the CB at the balance point.

Example 6 – skid-mounted cargo:

If the skid-mounted cargo is too large to fit on a scale at one time, use the CB formula. Consider the support braces between the skids to be axles.

Step 1. Support the overhang at the same height as the scale with a block of wood.

Step 2. Measure the distance from the RDL to the front and rear points of support (same as axles).

Step 3. Enter the weights and distances into the formula.

$$\frac{(1{,}500 \times 50) + (2{,}050 \times 110)}{3{,}550} = \frac{75{,}000 + 225{,}500}{3{,}550} =$$

$$\frac{300{,}000}{3{,}550} = 84.6 \text{ inches}$$

The CB of the cargo measured from the RDL is 85 inches.

International Markings and Road Signs. Personnel serving in overseas locations should be able to readily identify standardized vehicle markings and road signs. For guidelines concerning NATO military vehicle markings and illustrations of various road signs prescribed by NATO and the Geneva Convention, refer to Appendix D.

Hazardous Materials. Packages, freight containers, and means of transport containing hazardous materials must be marked, labeled, and placarded IAW 49 CFR, Part 172. Refer to Appendix E of this manual for guidance and illustrations of hazardous materials marking, labeling, and placarding for all modes of transportation.

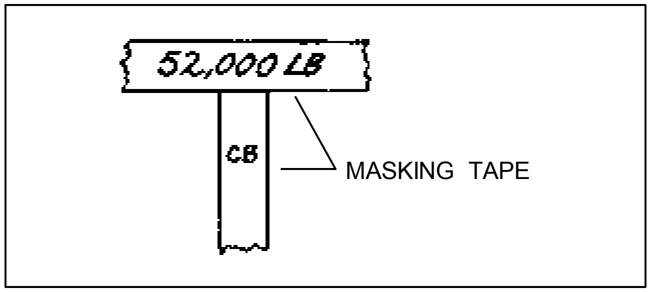


Figure 3-22. Center of balance marker

Section II
MOTOR TRANSPORT DATA

The information included here provides the motor transport planner with vehicle characteristics and capabilities. Other planning information includes statistics on safe vehicle distances, local and line-haul operations, and highway tonnage capabilities.

VEHICLE CHARACTERISTICS

Tables 3-7 through 3-22, pages 3-47 through 3-73 list mechanical data on authorized motor transport vehicles. This information includes truck performance data; CB of single-unit trucks; and axle weights, dimensions, and capacities for prime movers and towed vehicles.

PLANNING STATISTICS

Table 3-23, page 3-73, contains average vehicle stopping distances for prime movers and passenger vehicles. Use this table to determine safe vehicle gaps at various speeds on average, hard-surfaced roads. Since well trained drivers can reduce the distance traveled during the perception and reaction periods, the planner should consider the physical condition and training of drivers for a particular operation. Keep in mind that rain, snow, or ice present special conditions. Braking distances are based on the assumption that vehicles are loaded and have good brakes, tires, and traction. The average values in Table 3-23 have been determined from the standpoint of safety only; the tactical situation may require larger or smaller gaps. In the absence of definite information, the rule of thumb method may be used for certain speeds to determine the gap between vehicles in a convoy: speedometer reading (MPH) x 2 = gap in yards (or speedometer reading (KPH) x 1.2 = gap in meters). Use this method only for speeds marked with an asterisk in Table 3-23. See Figure 3-23, page 3-75, for illustrations of Army motor transport vehicles. See Appendix A for motor transport unit capabilities.

Table 3-7. Vehicle axle weights

VEHICLE	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Truck, cargo, 2 1/2-T, 6 x 6, M35A1	6,580	7,320	13,900	5,980	7,420	13,400	7,470	16,830	24,300	6,970	16,820	23,790
Truck, cargo, 2 1/2-T, 6 x 6, M35A2, M35A2C2	6,760	6,960	13,720	6,105	7,095	13,200	6,905	11,815	18,720	6,250	11,950	18,200
Truck, cargo, 2 1/2-T, 6 x 6, M36A2	6,850	8,260	15,110	6,250	8,360	14,610	7,700	17,810	25,510	7,100	17,910	25,010
Truck, cargo, 2 1/2-T, 6 x 6, M36A2C	7,140	8,270	15,410	6,510	8,380	14,890	7,375	13,035	20,410	6,745	13,145	19,890
Truck, tk, fuel-svc, 1,200-gal, 2 1/2-T, 6 x 6, M49A2C	6,420	8,440	14,860	5,765	8,575	14,340	6,980	11,680	18,660	7,635	11,545	19,180
Truck, tk, water, 1,000-gal, 2 1/2-T, 6 x 6, M50A2	6,410	8,170	14,580	5,790	8,290	14,080	7,220	15,710	22,930	6,700	15,730	22,430
Truck, tk, water, 1,000-gal, 2 1/2-T, 6 x 6, M50A3	6,310	8,840	15,150	5,655	8,975	14,630	7,525	11,875	19,400	6,870	12,010	18,800
Truck, van, shop, 2 1/2-T, 6 x 6, M109A3	6,865	8,935	15,800	6,210	9,070	15,280	7,025	13,775	20,800	6,370	13,910	20,280
Truck, repair, shop, 2 1/2-T, 6 x 6, M185A3	6,875	10,405	17,280	6,220	10,540	16,760	7,035	15,245	22,280	6,380	15,380	21,760
Truck, van, expansible, 2 1/2-T, 6 x 6, M292A2	—	—	—	8,045	13,164	21,209	—	—	—	8,635	17,974	26,609
Truck, van, expansible, 2 1/2-T, 6 x 6, M292A5	—	—	—	7,520	15,410	22,930	—	—	—	8,110	20,220	28,330

Table 3-7. Vehicle axle weights (continued)

	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
VEHICLE	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Truck, trac, 2 1/2-T, 6 x 6, M275A2	6,570	6,075	12,645	5,905	6,220	12,125	6,665	12,880	19,645	6,100	13,025	19,125
Truck, dump, 2 1/2-T, 6 x 6, M342A2	6,910	8,865	15,775	6,255	9,000	15,255	6,975	13,800	20,775	6,320	13,935	20,255
Truck, cargo, 5-T, 6 x 6, M54, M54A1, M54A1C	8,735	11,210	19,945	7,884	11,347	19,231	9,404	20,891	30,295	8,553	21,028	29,581
Truck, cargo, 5-T, 6 x 6, M54A2	8,700	11,700	20,400	7,720	11,820	19,540	9,930	30,870	40,800	8,950	30,990	39,940
Truck, cargo, 5-T, 6 x 6, M54A2C	8,720	11,940	20,660	7,740	12,060	19,800	9,890	31,170	41,060	8,910	31,290	40,200
Truck, cargo, 5-T, 6 x 6, M55	9,000	15,060	24,060	8,150	15,200	23,350	9,180	24,880	34,060	8,327	25,022	33,349
Truck, cargo, 5-T, 6 x 6, M55A2	8,840	15,060	23,900	7,880	15,160	23,040	9,450	24,880	34,330	8,490	25,022	33,512
Truck, cargo, 5-T, 6 x 6, M813	9,850	11,170	21,020	9,065	11,290	20,355	10,175	20,845	31,020	9,390	20,965	30,355
Truck, cargo, 5-T, 6 x 6, M813A1	9,855	11,265	21,120	9,070	11,385	20,455	10,135	20,985	31,120	9,350	21,205	30,455
Truck, cargo, 5-T, 6 x 6, M814	10,000	13,540	23,540	9,235	13,640	22,875	10,000	23,495	33,495	9,280	23,595	32,875
Truck, cargo, 5-T, 6 x 6, M923	—	—	—	9,700	11,770	21,470	—	—	—	9,855	21,615	31,175

Table 3-7. Vehicle axle weights (continued)

VEHICLE	CURB WEIGHT (LB) AXLE LOAD W/WINCH Front	Rear	Total	CURB WEIGHT (LB) AXLE LOAD W/O WINCH Front	Rear	Total	GROSS WEIGHT, PAYLOAD & PERSONNEL (LB) AXLE LOAD W/WINCH Front	Rear	Total	GROSS WEIGHT, PAYLOAD & PERSONNEL (LB) AXLE LOAD W/O WINCH Front	Rear	Total
Truck, cargo, 5-T, 6 x 6, M923A1	—	—	—	10,205	11,970	22,175	—	—	—	10,185	21,990	32,175
Truck, cargo, 5-T, 6 x 6, M923A2	—	—	—	8,930	12,000	20,930	—	—	—	8,910	22,020	30,930
Truck, cargo, 5-T, 6 x 6, M925	10,750	11,820	22,570	—	—	—	10,905	21,665	32,570	—	—	—
Truck, cargo, 5-T, 6 x 6, M925A1	11,225	12,020	23,275	—	—	—	11,235	22,040	33,275	—	—	—
Truck, cargo, 5-T, 6 x 6, M925A2	9,980	12,050	22,030	—	—	—	9,960	22,070	32,030	—	—	—
Truck, cargo, 5-T, 6 x 6, M927	—	—	—	10,200	14,100	24,300	—	—	—	10,205	24,095	34,300
Truck, cargo, 5-T, 6 x 6, M927A1	—	—	—	10,985	14,080	25,065	—	—	—	11,185	23,880	35,065
Truck, cargo, 5-T, 6 x 6, M927A2	—	—	—	9,450	14,340	23,790	—	—	—	9,430	24,360	33,790
Truck, cargo, 5-T, 6 x 6, M928	11,230	14,170	25,400	—	—	—	11,235	24,165	35,400	—	—	—
Truck, cargo, 5-T, 6 x 6, M928A1	12,045	13,920	26,165	—	—	—	12,245	23,920	36,165	—	—	—
Truck, cargo, 5-T, 6 x 6, M928A2	10,480	14,410	24,890	—	—	—	10,460	24,430	34,890	—	—	—

Table 3-7. Vehicle axle weights (continued)

VEHICLE	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Truck, dump, 5-T, 6 x 6, M51	9,305	11,580	22,665	8,460	13,250	21,980	9,503	11,580	21,083	8,658	11,661	20,319
Truck, dump, 5-T, 6 x 6, M51A2	9,150	13,550	22,700	8,260	13,660	21,920	9,503	23,160	32,663	8,658	23,322	31,980
Truck, dump, 5-T, 6 x 6, M817	10,400	13,355	23,755	9,610	13,480	23,090	10,670	23,085	33,755	9,880	23,210	33,090
Truck, dump, 5-T, 6 x 6, M929	—	—	—	10,290	13,700	23,990	—	—	—	10,495	23,495	33,990
Truck, dump, 5-T, 6 x 6, M929A1	—	—	—	10,080	13,750	23,830	—	—	—	11,185	23,880	35,065
Truck, dump, 5-T, 6 x 6, M929A2	—	—	—	9,710	14,110	23,820	—	—	—	9,910	23,910	33,820
Truck, dump, 5-T, 6 x 6, M930	11,340	13,750	25,090	—	—	—	11,545	23,545	35,090	—	—	—
Truck, dump, 5-T, 6 x 6, M930A1	10,680	13,760	22,440	—	—	—	12,245	23,920	36,165	—	—	—
Truck, dump, 5-T, 6 x 6, M930A2	10,770	14,150	24,920	—	—	—	10,970	23,950	34,920	—	—	—
Truck, trac, 5-T, 6 x 6, M52	9,008	9,998	18,996	8,163	10,150	18,313	9,384	24,612	33,996	8,539	24,774	33,313
Truck, trac, 5-T, 6 x 6, M52A1	9,220	10,230	19,450	8,500	10,560	19,060	9,510	24,940	34,450	8,730	25,330	34,060

Table 3-7. Vehicle axle weights (continued)

	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
VEHICLE	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Truck, trac, 5-T, 6 x 6, M52A2	9,020	9,680	18,700	8,030	9,810	17,840	9,384	24,612	33,996	8,539	24,330	33,313
Truck, trac, 5-T, 6 x 6, M818	10,260	9,905	20,165	9,470	10,030	19,500	10,635	24,530	35,165	9,845	24,655	34,500
Truck, trac, 5-T, 6 x 6, M819	14,665	20,400	35,065	—	—	—	14,665	32,400	47,065	—	—	—
Truck, trac, 5-T, 6 x 6, M931	—	—	—	10,077	13,751	23,828	—	—	—	10,710	25,430	36,140
Truck, trac, 5-T, 6 x 6, M931A1	—	—	—	10,340	10,800	21,140	—	—	—	10,710	25,430	36,140
Truck, trac, 5-T, 6 x 6, M931A2	—	—	—	9,065	10,830	19,895	—	—	—	9,435	25,460	34,895
Truck, trac, 5-T, 6 x 6, M932	10,679	13,761	22,440	—	—	—	11,770	25,470	37,240	—	—	—
Truck, trac, 5-T, 6 x 6, M932A1	11,400	10,840	22,240	—	—	—	11,770	25,470	37,240	—	—	—
Truck, trac, 5-T, 6 x 6, M932A2	10,125	10,870	20,995	—	—	—	10,495	25,500	35,995	—	—	—
Truck, trac, wkr, 5-T, 6 x 6, M62	9,325	24,000	33,325	—	—	—	5,027	35,298	40,325	—	—	—
Truck, wkr, 5-T, 6 x 6, M543A1, M543A2	9,090	25,160	34,250	—	—	—	5,115	36,535	41,650	—	—	—

Table 3-7. Vehicle axle weights (continued)

VEHICLE	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Truck, wkr, 5-T, 6 x 6, M816	10,530	24,520	35,050	—	—	—	13,060	35,460	48,430	—	—	—
Truck, wkr, 5-T, 6 x 6, M936	11,630	25,970	37,600	—	—	—	7,690	36,910	44,600	—	—	—
Truck, wkr, 5-T, 6 x 6, M936A1	12,075	26,080	38,155	—	—	—	7,835	37,320	45,155	—	—	—
Truck, wkr, 5-T, 6 x 6, M936A2	10,800	26,110	36,910	—	—	—	6,560	37,350	43,910	—	—	—
Truck, van, expansible, 5-T, 6 x 6, M291A2C	—	—	—	8,900	16,900	25,800	—	—	—	9,860	31,340	41,200
Truck, van, expansible, 5-T, 6 x 6, M820	—	—	—	10,775	17,420	28,195	—	—	—	10,950	22,245	33,195
Truck, van, expansible, 5-T, 6 x 6, M820A1	—	—	—	10,750	17,145	27,895	—	—	—	10,925	21,970	32,895
Truck, van, expansible, 5-T, 6 x 6, M820A2	—	—	—	10,070	20,125	30,195	—	—	—	10,245	24,950	35,195
Truck, van, expansible, 5-T, 6 x 6, M934	—	—	—	10,590	17,850	28,440	—	—	—	10,765	22,675	33,440
Truck, van, expansible, 5-T, 6 x 6, M934A1	—	—	—	11,190	18,090	29,280	—	—	—	11,410	22,870	34,280
Truck, van, expansible, 5-T, 6 x 6, M934A2	—	—	—	9,915	18,120	28,035	—	—	—	10,135	22,900	33,035

Table 3-7. Vehicle axle weights (continued)

	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
VEHICLE	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Truck, van, expansible, 10-T, 8 x 8, M977	20,930	16,935	37,865	20,430	16,535	36,965	30,000	32,000	62,000	—	—	—
Truck, van, expansible, 10-T, 8 x 8, M985	20,160	19,140	39,300	19,660	18,740	38,400	26,970	34,330	61,300	26,470	33,930	60,400
Truck, van, expansible, 10-T, 8 x 8, M983	24,220	14,750	38,970	23,730	14,340	38,070	24,220	26,750	50,970	23,730	26,340	50,070
Truck, trac, 10-T, 6 x 6, M123A1C	12,650	17,580	30,230	—	—	—	13,750	46,490	60,240	—	—	—
Truck, trac, 10-T, 6 x 6, M916	—	—	27,971	—	—	—	14,220	42,340	56,560	—	—	—
Truck, trac, 10-T, 6 x 6, M916A1	—	—	27,750	—	—	—	16,000	52,000	68,000	—	—	—
Truck, trac, 10-T, 8 x 6, M920	26,020	10,180	36,200	—	—	—	27,920	43,640	71,560	—	—	—
Truck, trac, 10-T, 8 x 8, PLS, M1074	—	—	—	30,200	24,810	55,010	—	—	—	32,110	55,890	88,000
Truck, trac, 10-T, 8 x 8, PLS, M1075	—	—	—	26,650	23,310	49,960	—	—	—	28,550	54,410	82,960
Truck, trac, 14-T, 8 x 4, M915	—	—	—	9,920	9,710	19,630	—	—	—	11,313	37,658	48,971
Truck, trac, 14-T, 8 x 4, M915A1	—	—	—	9,920	9,800	19,720	—	—	—	11,580	36,540	48,120

Table 3-7. Vehicle axle weights (continued)

VEHICLE	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Truck, trac, 14-T, 8 x 4, M915A2	—	—	—	—	—	18,700	—	—	—	12,000	38,000	50,000
Truck, trac, 22 1/2-T, 8 x 8, M911	19,954	19,998	39,952	—	—	—	21,800	58,600	80,400	—	—	—
Truck, trac, 22 1/2-T, 8 x 8, M1070	18,368	22,722	41,090	—	—	—	21,472	64,763	86,235	—	—	—
Stlr, van, elct, 6-T, 2-whl, M373A2	—	—	—	—	6,040	9,430	—	—	—	—	12,540	21,430
Stlr, van elct, 6-T, 2-whl, M348A2	—	—	—	—	5,090	9,810	—	—	—	—	12,930	21,810
Stlr, van, expansible, 6-T, 4-whl, M313	—	—	—	—	11,225	15,350	—	—	—	—	20,000	27,350
Stlr, van, stor, 6-T, 4-whl, M750	—	—	—	—	9,160	15,310	—	—	—	—	12,700	20,800
Stlr, stake, 6-T, 4-whl, M127	—	—	—	—	9,950	13,500	—	—	—	—	23,800	37,500
Stlr, stake, 12-T, 4-whl, M127A1, M127A1C	—	—	—	—	10,230	14,240	—	—	—	—	23,500	38,240
Stlr, stake, 12-T, 4-whl, M127A2C	—	—	—	—	10,080	13,840	—	—	—	—	23,930	37,840
Stlr, van, cargo, 12-T, 4-whl, M128A1C	—	—	—	—	10,830	14,695	—	—	—	—	24,600	38,695

Table 3-7. Vehicle axle weights (continued)

VEHICLE	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Stlr, van, cargo, 12-T, 4-whl, M128A2C	—	—	—	—	10,600	15,220	—	—	—	—	24,570	39,220
Stlr, van, supply, 12-T, 4-whl, M129A1C	—	—	—	—	11,170	15,245	—	—	—	—	24,860	39,245
Stlr, van, supply, 12-T,4-whl, M129A2C	—	—	—	—	10,700	15,400	—	—	—	—	24,670	39,400
Stlr, low-bed, wkr, 12-T, 4-whl, M269, M269A1	—	—	—	—	10,520	14,200	—	—	—	—	28,040	38,200
Stlr, tk, fuel, 12-T, 4-whl, M967, M967A1	—	—	—	—	9,720	14,040	—	—	—	—	29,220	39,840
Stlr, tk, fuel, 12-T, 4-whl, M969, M969A1	—	—	—	—	10,980	16,060	—	—	—	—	30,780	41,860
Stlr, tk, fuel, 12-T, 4-whl, M970, M970A1	—	—	—	—	11,490	16,810	—	—	—	—	29,220	42,610
Stlr, trk, fuel, 12-T, 4-whl, M131A2	—	—	—	—	8,900	12,400	—	—	—	—	21,020	32,744
Stlr, tk, fuel, 12-T, 4-whl, M131A4	—	—	—	—	9,470	12,900	—	—	—	—	22,640	36,165
Stlr, tk, fuel, 12-T, 4-whl, M131A4C	—	—	—	—	9,470	12,900	—	—	—	—	22,640	36,165
Stlr, tk, fuel, 12-T, 4-whl, M131A5	—	—	—	—	9,385	12,785	—	—	—	—	22,550	36,050

Table 3-7. Vehicle axle weights (continued)

VEHICLE	CURB WEIGHT (LB) AXLE LOAD W/WINCH Front	Rear	Total	CURB WEIGHT (LB) AXLE LOAD W/O WINCH Front	Rear	Total	GROSS WEIGHT, PAYLOAD & PERSONNEL (LB) AXLE LOAD W/WINCH Front	Rear	Total	GROSS WEIGHT, PAYLOAD & PERSONNEL (LB) AXLE LOAD W/O WINCH Front	Rear	Total
Stlr, tk, fuel, 7,500-gal, 4-whl, M1062	—	—	—	—	*	10,600	—	—	—	—	33,182	64,600
Stlr, low-bed, 22 1/2-T, 4-whl, M871	—	—	—	—	10,220	15,900	—	—	—	—	35,320	60,700
Stlr, low-bed, 22 1/2-T, 4-whl, M871A1, M871A2	—	—	—	—	8,140	12,240	—	—	—	—	32,300	57,240
Stlr, low-bed, 25-T, 4-whl, M172A1	—	—	—	—	11,510	16,600	—	—	—	—	41,606	66,600
Stlr, low-bed, 25-T, 4-whl, M172	—	—	—	—	11,510	16,600	—	—	—	—	41,606	66,600
Stlr, flat-bed, 34-T, 6-whl, M872	—	—	—	—	12,840	16,800	—	—	—	—	56,400	84,000
Stlr, flat-bed, 34-T, 6-whl, M872A1, M872A2, M872A3	—	—	—	—	12,140	19,240	—	—	—	—	56,770	86,440
Stlr, low-bed, 40-T, 6-whl, M870	—	—	—	—	11,000	16,500	—	—	—	—	56,500	96,500
Stlr, HET, 60-T, 8-whl, M747	—	—	—	—	24,000	31,000	—	—	—	—	106,000	152,000
Stlr, HET, 70-T, 8-whl, M1000	—	—	—	—	41,680	50,400	—	—	—	—	146,000	190,400
Trailer, cargo, 3/4-T, 2-whl, M101	—	—	—	—	1,240	1,340	—	—	—	—	2,670	2,840

Table 3-7. Vehicle axle weights (continued)

	CURB WEIGHT (LB)						GROSS WEIGHT, PAYLOAD & PERSONNEL (LB)					
	AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH			AXLE LOAD W/WINCH			AXLE LOAD W/O WINCH		
VEHICLE	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Trailer, cargo, 3/4-T, 2-whl, M101A1	—	—	—	—	1,225	1,340	—	—	—	—	2,511	2,780
Trailer, ammo, 1 1/2-T, 2-whl, M332	—	—	—	—	2,495	2,875	—	—	—	—	5,511	5,875
Trailer, cargo, 1 1/2-T, 2-whl, M105A2	—	—	—	—	2,520	2,750	—	—	—	—	5,385	5,750
Trailer, tk, water, 1 1/2-T, 2-whl, M107A1	—	—	—	—	2,010	2,280	—	—	—	—	5,345	5,615
Trailer, tk, water, 1 1/2-T, 2-whl, M107A2	—	—	—	—	2,100	2,380	—	—	—	—	5,710	5,440
Trailer, tk, water, 1 1/2-T, 2-whl, M149	—	—	—	—	2,170	2,500	—	—	—	—	5,575	5,830
Trailer, tk, water, 1 1/2-T, 2-whl, M149A1	—	—	—	—	2,350	2,710	—	—	—	—	5,690	6,040
Trailer, tk, water, 1 1/2-T, 2-whl, M149A2	—	—	—	—	2,385	2,730	—	—	—	—	5,717	6,062
Trailer, PLS, 16.5-T, M1076	—	—	—	—	9,380	16,530	—	—	—	—	31,220	49,520

Table 3-8. Center of balance: location on single-unit vehicles

VEHICLE	CB WITHOUT PAYLOAD				CB WITH EVENLY DISTRIBUTED PAYLOAD			
	LOCATION W/WINCH		LOCATION W/O WINCH		LOCATION W/WINCH		LOCATION W/O WINCH	
	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)
Truck, amb, 1 1/4-T, 4 x 4, M1010	—	—	36.4	66.0	—	—	—	—
Truck, cargo, 1 1/4-T, 4 x 4, M1008	—	—	30.5	57.6	—	—	—	80.5
Truck, cargo, 1 1/4-T, 4 x 4, M1028	—	—	30.5	54.9	—	—	—	83.9
Truck, cargo, 2 1/2-T, 6 x 6, M35A1	38.0	81.0	38.0	85.5	46.0	110.0	46.5	113.0
Truck, cargo, 2 1/2-T, 6 x 6, M35A2, M35A2C	36.5	78.1	36.3	82.8	45.6	97.2	45.6	101.1
Truck, cargo, 2 1/2-T, 6 x 6, M36A2	36.3	102.0	36.1	106.9	45.3	121.3	45.3	125.6
Truck, tk, fuel-serv, 1,200-gal, 2 1/2-T, 6 x 6, M49A2C	41.0	87.5	41.0	92.1	46.9	92.7	46.9	96.4
Truck, tk, water, 1,000-gal, 2 1/2-T, 6 x 6, M50A2	41.0	86.0	41.0	90.7	46.9	89.4	46.9	93.3
Truck, tk, water, 1,000-gal, 2 1/2-T, 6 x 6, M50A3	41.0	89.9	41.0	94.5	47.7	94.3	47.7	98.0
Truck, van, shop, 2 1/2-T, 6 x 6, M109A3	47.4	87.1	47.6	91.4	—	102.0	—	105.6
Truck, van, repair shop, 2 1/2-T, 6 x 6, M185A3	92.7	51.3	96.8	—	105.4	—	108.8	51.0
Truck, van, expansible, 2 1/2-T, 6 x 6, M292A2	—	—	57.0	120.0	—	—	65.0	134.0
Truck, van, expansible, 2 1/2-T, 6 x 6, M292A5	—	—	58.0	125.0	—	—	65.0	143.0
Truck, trac, 2 1/2-T, 6 x 6, M275A1, M275A2	32.5	68.2	32.0	72.8	—	93.1	—	96.7

Table 3-8. Center of balance: location on single-unit vehicles (continued)

VEHICLE	CB WITHOUT PAYLOAD				CB WITH EVENLY DISTRIBUTED PAYLOAD			
	LOCATION W/WINCH		LOCATION W/O WINCH		LOCATION W/WINCH		LOCATION W/O WINCH	
	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)
Truck, dump, 2 1/2-T, 6 x 6, M342A2	39.4	86.5	39.9	90.0	44.2	102.3	44.2	105.9
Truck, cargo, 5-T, 6 x 6, M54	39.9	99.8	40.1	105.9	54.1	124.4	54.7	128.8
Truck, cargo, 5-T, 6 x 6, M54A2	40.0	103.0	40.5	108.0	54.0	135.0	54.5	139.0
Truck, cargo, 5-T, 6 x 6, M54A2C	40.0	104.0	40.5	109.0	54.0	136.0	54.5	140.0
Truck, cargo, 5-T, 6 x 6, M55	40.3	134.8	—	—	49.1	157.1	—	—
Truck, cargo, 5-T, 6 x 6, M55A2	40.5	135.5	40.0	141.5	55.0	170.2	54.5	173.0
Truck, cargo, 5-T, 6 x 6, M813	40.5	95.1	40.0	99.0	50.3	120.5	49.8	123.9
Truck, cargo, 5-T, 6 x 6, M813A1	40.5	95.2	40.0	99.0	50.3	120.7	49.8	124.0
Truck, cargo, 5-T, 6 x 6, M814	38.6	123.7	38.2	128.2	61.6	150.7	61.2	154.3
Truck, cargo, 5-T, 6 x 6, M923	—	—	40.1	98.0	—	—	51.0	123.0
Truck, cargo, 5-T, 6 x 6, M923A1	—	—	42.8	96.6	—	—	54.6	122.4
Truck, cargo, 5-T, 6 x 6, M925	40.1	93.7	—	—	51.1	120.0	—	—
Truck, cargo, 5-T, 6 x 6, M925A1	43.3	92.4	—	—	55.1	118.6	—	—
Truck, cargo, 5-T, 6 x 6, M927	—	—	39.2	125.6	—	—	49.4	151.0
Truck, cargo, 5-T, 6 x 6, M927A1	—	—	41.8	122.9	—	—	56.0	149.7

Table 3-8. Center of balance: location on single-unit vehicles (continued)

VEHICLE	CB WITHOUT PAYLOAD				CB WITH EVENLY DISTRIBUTED PAYLOAD			
	LOCATION W/WINCH		LOCATION W/O WINCH		LOCATION W/WINCH		LOCATION W/O WINCH	
	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)
Truck, cargo, 5-T, 6 x 6, M928	39.5	120.0	—	—	49.3	147.0	—	—
Truck, cargo, 5-T, 6 x 6, M928A1	42.1	118.3	—	—	56.3	145.2	—	—
Truck, dump, 5-T, 6 x 6, M51	38.7	98.3	38.9	102.7	47.4	118.4	47.7	121.7
Truck, dump, 5-T, 6 x 6, M51A2	38.7	99.7	38.7	104.0	58.0	130.0	58.0	133.0
Truck, dump, 5-T, 6 x 6, M817	42.3	94.6	41.7	98.2	49.8	114.2	49.2	117.1
Truck, dump, 5-T, 6 x 6, M929	—	—	44.1	95.2	—	—	50.5	116.0
Truck, dump, 5-T, 6 x 6, M929A1	—	—	46.8	93.8	—	—	49.7	113.7
Truck, dump, 5-T, 6 x 6, M930	41.4	91.4	—	—	50.5	113.0	—	—
Truck, dump, 5-T, 6 x 6, M930A1	47.1	90.1	—	—	50.0	110.4	—	—
Truck, trac, 5-T, 6 x 6, M52	34.5	87.8	34.0	92.6	46.2	120.7	45.7	124.0
Truck, trac, 5-T, 6 x 6, M52A2	34.0	88.5	34.5	94.0	—	131.0	—	134.0
Truck, trac, 5-T, 6 x 6, M818	38.0	82.7	38.5	86.2	—	116.4	—	119.2
Truck, trac, wkr, 5-T, 6 x 6, M819	56.6	125.2	—	—	—	148.2	—	—
Truck, wkr, 5-T, 6 x 6, M62	—	124.5	—	—	—	156.4	—	—
Truck, wkr, 5-T, 6 x 6, M543A2	47.0	131.0	—	—	—	—	—	—

Table 3-8. Center of balance: location on single-unit vehicles (continued)

VEHICLE	CB WITHOUT PAYLOAD				CB WITH EVENLY DISTRIBUTED PAYLOAD			
	LOCATION W/WINCH		LOCATION W/O WINCH		LOCATION W/WINCH		LOCATION W/O WINCH	
	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)
Truck, wkr, 5-T, 6 x 6, M816	47.9	134.9	—	—	43.0	150.9	—	—
Truck, wkr, 5-T, 6 x 6, M936	43.2	125.1	—	—	—	165.1	—	—
Truck, wkr, 5-T, 6 x 6, M936A1	52.9	122.4	—	—	—	148.0	—	—
Truck, van, expansible, 5-T, 6 x 6, M291A2C	—	—	56.0	141.0	—	—	64.0	163.0
Truck, van, expansible, 5-T, 6 x 6, M820	—	—	54.3	133.3	—	—	—	144.4
Truck, van, expansible, 5-T, 6 x 6, M820A1	—	—	54.3	132.7	—	—	—	143.9
Truck, van, expansible, 5-T, 6 x 6, M820A2	—	—	56.1	143.5	—	—	—	152.5
Truck, van, expansible, 5-T, 6 x 6, M934	—	—	54.3	138.0	—	—	—	161.2
Truck, van, expansible, 5-T, 6 x 6, M934A1	—	—	57.5	132.8	—	—	—	143.4
Truck, van, expansible, 5-T, 6 x 6, M935	—	—	56.9	146.9	—	—	—	155.5
Truck, cargo, 10-T, 8 x 8, M977	44.7	95.0	—	—	62.4	113.2	—	—
Truck, cargo, 10-T, 8 x 8, M985	45.3	100.7	—	—	67.4	117.6	—	—
Truck, trac, 10-T, 8 x 8, M983	43.0	59.7	—	—	—	—	—	—
Truck, wkr, 10-T, 8 x 8, M984	45.5	101.0	—	—	—	—	—	—
Truck, fuel, svc, 10-T, 8 x 8, M983	49.0	65.6	—	—	—	—	—	—

Table 3-8. Center of balance: location on single-unit vehicles (continued)

VEHICLE	CB WITHOUT PAYLOAD				CB WITH EVENLY DISTRIBUTED PAYLOAD			
	LOCATION W/WINCH		LOCATION W/O WINCH		LOCATION W/WINCH		LOCATION W/O WINCH	
	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)	Above Ground (In)	Behind Front Axle CL (In)
Truck, trac, 16.5-T, 10 x 10, PLS, M1074	—	—	55.0	101.0	—	—	65.0	144.0
Truck, trac, 16.5-T, 10 x 10, PLS w/crane, M1075	—	—	55.0	105.0	—	—	65.0	148.0
Truck, trac, 22 1/2-T, 8 x 8, M1070	43.67	118.68	—	—	—	—	—	—
Truck, utility, 3/4-T, 4 x 4, M1009	—	—	30.8	48.5	—	—	—	80.5

Table 3-9. Dimensions and loading capacity for cargo truck bodies

VEHICLE TYPE	CARGO DECK DIMENSIONS Length (in)	Width (in)	Height Above Ground (in)	CARGO BODY LOADING MEASUREMENTS Under Bows (in)	Under Bows (cu ft)	Top of Side Racks (in)	Top of Side Racks (cu ft)	Top of Steering Wheel (in)	Top of Steering Wheel (cu ft)
1 1/4-ton:									
M880, M881	98.6	69.9	34.0	NA	NA	NA	NA	39.5	151.9 [1, 2]
M882	98.6	69.9	34.0	NA	NA	NA	NA	39.5	124.6 [1, 2, 3]
M883, M884	98.6	69.9	34.0	NA	NA	NA	NA	39.5	151.9 [1, 2]
M885	98.6	69.9	34.0	NA	NA	NA	NA	39.5	151.9 [1, 2, 4]
M890, M891	98.6	69.9	31.0	NA	NA	NA	NA	39.5	151.9 [1, 2]
M892	98.6	69.9	31.0	NA	NA	NA	NA	39.5	151.9 [1, 2, 5]
2 1/2-ton:									
M35AI, M35A2	146.8	88.0	51.9	60.0	441.9 [6]	36.5	272.8	28.9	216.0
M35A2C	147.0	87.6	52.5	60.0	440.5 [6]	36.5	272.0	28.8	214.6
M36A2	210.0	88.0	51.8	71.8	759.3 [8]	38.0	406.4	30.0	320.8
5-ton:									
M54, M54A1	168.0	88.0	56.5	60.0	480.2 [10, 11]	36.5	286.1 [10]	29.0	222.0 [10]
M54A1C	168.0	88.0	55.5	60.0	482.5 [10, 11]	36.5	287.5 [10]	30.0	231.7 [10]
M54A2	168.0	88.0	55.5	61.0	480.2 [10, 11]	36.5	286.1 [10]	29.0	222.0 [10]
M54A2C	168.0	88.4	55.5	60.0	482.5 [10, 11]	36.5	287.5 [10]	30.0	231.7 [10]
M55, M55A2	244.0	88.0	57.2	61.3	751.5 [12]	36.5	453.5	28.0	360.3
M813	168.0	88.3	56.8	57.2	468.0 [12, 15]	36.5	298.8 [15]	29.3	237.0 [15]
M813A1	168.0	88.3	56.8	57.4	468.0 [12, 15]	36.5	298.8 [15]	29.3	237.0 [15]
M814	243.8	87.8	57.3	60.0	733.0 [12]	36.3	449.6	31.3	387.5
M821	218.8	97.8	64.0	48.8	604.3 [13]	(13)	(13)	(13)	(13)
M923, M925 M923A1, M923A2,	168.0	88.3	56.8	57.4	468.0 [12, 15]	36.5	298.8 [15]	29.3	237.0 [15]

Table 3-9. Dimensions and loading capacity for cargo truck bodies (continued)

	CARGO DECK DIMENSIONS			CARGO BODY LOADING MEASUREMENTS					
				Under Bows		Top of Side Racks		Top of Steering Wheel	
VEHICLE TYPE	Length (in)	Width (in)	Height Above Ground (in)	(in)	(cu ft)	(in)	(cu ft)	(in)	(cu ft)
M925A1, M925A2	168.0	88.3	59.8	57.4	468.0 [12]	36.5	298.8 [15]	32.3	277.3
M927, M928	244.0	88.3	56.8	57.4	468.0 [12, 15]	36.5	298.8 [18]	29.3	237.0 [18]
M927A1, M928A1	244.0	88.3	59.8	57.4	468.0 [12, 15]	36.5	298.8 [18]	32.3	402.7
10-ton:									
M977	216.0	90.0	65.0	48.0 [9]	540.0 [18]	(16)	(17)	38.0 [2]	427.5 [2]
M985	216.0	90.0	65.0	48.0 [14]	540.0 [18]	(17)	(7)	38.0 [2]	427.5 [2]

[1] Cubic capacity reduced 5.6 cubic feet for wheel wells.
[2] Height and cube measured to top of cab.
[3] Cubic capacity reduced 27.3 feet for communications kit.
[4] Cubic capacity reduced 0.8 cubic feet for communications tie-down brackets.
[5] Cubic capacity reduced 40.1 cubic feet for communications kit.
[6] Cubic capacity reduced 6.6 cubic feet for curve of bows.
[7] See Top of Steering Wheel column for cube.
[8] Cubic capacity reduced 8.5 cubic feet for curve of bows.
[9] Cubic capacity reduced 27.0 cubic feet for spare tire and carrier in cargo body.
[10] Cubic capacity reduced 26.1 cubic feet for spare tire and carrier in cargo body.
[11] Cubic capacity reduced 7.0 cubic feet for curve of bows.
[12] Cubic capacity reduced 10.2 cubic feet for curve of bows.
[13] Height and cube measured to top of bulkhead.
[14] Height over spare tire.
[15] Cubic capacity reduced 14.5 cubic feet for spare tire and carrier in cargo body.
[16] Cubic capacity reduced 93.8 cubic feet for wheel wells.
[17] See Top of Steering Wheel column for height. Steering wheel is higher than side racks.
[18] Cube measured to top of spare tire.

Table 3-10. Dimensions and loading capacity for dump truck bodies

VEHICLE TYPE	CARGO DECK DIMENSIONS Length (in)	Width (in)	Height Above Ground (in)	CARGO BODY LOADING MEASUREMENTS Top of Panels (in)	Top of Panels (cu ft)	Top of Steering Wheel (in)	Top of Steering Wheel (cu ft)	Top of Shield (in)	Top of Shield (cu ft)
2 1/2-ton:									
M342A2	130.0	70.0	53.0	24.5	(1)	26.5	(1)	52.0	273.8
5-ton:									
M51	123.0	82.0	59.0	25.0	(1)	27.0	(1)	51.0	297.6
M51A2	123.0	82.0	59.0	25.0	(1)	27.0	(1)	51.0	297.6
M817	124.8	81.9	59.0	25.0	(1)	27.1	(1)	51.8	306.3
M929	124.8	81.9	59.0	28.0	(1)	27.1	(1)	51.8	306.3
M930	124.8	81.9	59.0	25.0	(1)	27.1	(1)	51.8	306.3
20-ton:									
F5070	191.5	85.1	66.5	34.3	(2)	NA	(2)	58.8	537.0 [3, 4]
M917	216.0	84.0	68.0	31.0	(2)	NA	(2)	(2)	753.6 [3]

[1] Removed cab shield stowed in dump body. See Top of Cab Shield column for cube.

[2] Cab shield cannot be removed. See Top of Cab Shield column for cube.

[3] Cube capacity reduced 12.9 cubic feet for hoist doghouse in dump body.

[4] Cube capacity reduced 1.8 cubic feet for ribs in dump body.

Table 3-11. Dimensions and loading capacity for cargo trailer bodies

VEHICLE TYPE	CARGO DECK DIMENSIONS			CARGO BODY LOADING MEASUREMENTS					
	Length (in)	Width (in)	Height Above Ground (in)	Under Bows (in)	Under Bows (cu ft)	Top of Side Racks (in)	Top of Side Racks (cu ft)	Top of Side Panels (in)	Top of Side Panels (cu ft)
1/4-ton:									
M100	71.5	37.8	24.5	NA	NA	NA	NA	18.0	29.7 [1]
3/4-ton:									
M101	94.8	65.3	31.7	49.0	170.5 [2, 3]	33.3	114.6 [2]	18.3	60.9 [2]
M101A1	94.3	66.0	34.0	49.0	170.5 [2, 3]	33.3	114.6 [2]	18.3	60.9 [2]
1 1/2-ton:									
M104, M104A1	110.0	74.0	38.3	59.3	273.2 [4, 5]	45.3	207.7 [4]	18.0	79.1 [4]
M105	109.8	74.0	37.0	60.0	276.0 [4, 5]	45.0	205.0 [4]	18.0	70.0[4]
M105A1, M105A2	109.8	74.0	37.0	60.0	276.0 [4, 5]	45.0	205.9 [4]	18.0	79.0 [4]

[1] Cubic capacity increased because top 4.5 inches of side panels are 46.0 inches wide.

[2] Cubic capacity reduced 4.6 cubic feet for wheel wells.

[3] Cubic capacity reduced 0.4 cubic feet for curve of bows.

[4] Cubic capacity reduced 5.6 cubic feet for wheel wells.

[5] Cubic capacity reduced 0.5 cubic feet for curve of bows.

Table 3-12. Dimensions and loading capacity for stake and platform semitrailer cargo bodies

VEHICLE TYPE	CARGO DECK DIMENSIONS Length (in)	Width (in)	CARGO BODY LOADING MEASUREMENTS Height Above Ground (in)	Height (in)	Capacity (cu ft)
12-ton:					
M127	335.8	88.8	60.6	47.8	824.8
M127A1	335.8	88.8	60.5	47.8	824.8
M127A1C	335.8	88.8	60.5	48.0	828.3
M237A2C	335.8	88.8	59.8	48.0	828.3
M270A1	459.8	84.0	51.8	48.8	1,090.7
22 1/2-ton:					
M871	349.3	87.3	55.4	48.0	847.1
M871A1, M871A2	372.0	87.3	55.0	48.0	902.1
34-ton:					
M872, M872A2	484.8	93.0	60.0	52.0	1,356.8
M872A1, M872A3	484.8	93.0	55.0	52.0	1,356.8

Table 3-13. Dimensions and loading capacity for van semitrailer cargo bodies

VEHICLE TYPE	CARGO DECK DIMENSIONS Length (in)	Width (in)	CARGO BODY LOADING MEASUREMENTS Height Above Ground (in)	Height (in)	Capacity (cu ft)
12-ton:					
M128, M128A1	335.5	89.0	57.0	78.5	1,356.4
M128A1C	336.0	89.0	57.0	78.5	1,358.4
M128A2C	337.5	89.5	60.0	78.5	1,372.2

Table 3-14. Shipping dimensions and cube for cargo trucks

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	TOP OF SIDE RACKS Height (in)	TOP OF SIDE RACKS Cube (cu ft)	TOP OF STEERING WHEEL Height (in)	TOP OF STEERING WHEEL Cube (cu ft)
1 1/4-ton:						
M880, M881	219	80	NA	NA	74 [3]	751 [3]
M882	219	82	NA	NA	74 [3]	769 [3]
M883, M884, M885	219	80	NA	NA	74 [3]	751 [3]
M890, M891	219	80	NA	NA	71 [3]	720 [3]
M892	219	82	NA	NA	71 [3]	738 [3]
2 1/2-ton:						
M35A1, M35A2	265	96	89 [1]	1,311 [2]	81 [1]	1,193 [2]
M35A1 WWN, M35A2 WWN	279	96	89 [1]	1,380 [1]	81 [1]	1,256 [2]
M35A2C	265	98	89 [1]	1,338 [2]	82 [1]	1,233 [2]
M35A2C WWN	279	98	89 [1]	1,409 [2]	82 [1]	1,298 [2]
M36A2	329	96	89 [1]	1,597 [2]	81 [1]	1,458 [2]
M36A2 WWN	344	96	89 [1]	1,701 [2]	81 [1]	1,548 [2]
5-ton:						
M54, M54A1	297	98	93 [1]	1,566 [2]	86 [1]	1,449 [2]
M54 WWN, M54A1 WWN	314	98	93 [1]	1,657 [2]	86 [1]	1,532 [2]
M54A1C, M54A2C	298	99	92 [1]	1,571 [2]	86 [1]	1,469 [2]
M54A1C WWN	315	99	92 [1]	1,661 [2]	86 [1]	1,552 [2]
M54A2	297	98	93 [1]	1,566 [2]	86 [1]	1,449 [2]
M54A2 WWN	314	98	93 [1]	1,657 [2]	86 [1]	1,532 [2]
M54A2C WWN	314	99	92 [1]	1,655 [2]	86 [1]	1,547 [2]
5-ton:						
M55, M55A2	377	98	93 [1]	1,989 [2]	86 [1]	1,839 [2]
M55 WWN, M55A2 WWN	389	98	93 [1]	2,052 [2]	86 [1]	1,898 [2]
M812	399	124	139 [6]	3,980 [6]	(7)	(6)
M813	304	98	94 [1]	1,621 [2]	87 [1]	1,500 [2]
M813 WWN	320	98	94 [1]	1,706 [2]	87 [1]	1,579 [2]
M813A1	307	99	94 [1]	1,654 [2]	87 [1]	1,531 [2]

Table 3-14. Shipping dimensions and cube for cargo trucks (continued)

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	TOP OF SIDE RACKS Height (in)	TOP OF SIDE RACKS Cube (cu ft)	TOP OF STEERING WHEEL Height (in)	TOP OF STEERING WHEEL Cube (cu ft)
M813A1 WWN	323	99	94 [1]	1,740 [2]	87 [1]	1,620 [2]
M814	378	98	94 [1]	2,016 [2]	89 [1]	1908 [2]
M814 WWN	396	98	94 [1]	2,111 [2]	89 [1]	1,999 [2]
M821 WWN	379	115	113 [1,5]	2,851 [2,5]	(1, 5)	(2, 5)
M923	314	98	94 [1]	1,674 [2]	87	1,550
M923A1, M923A2	311	97	97 [1]	1,694 [2]	94	1,641
M925 WWN	327	98	94 [1]	1,744 [2]	87	1,614
M925A1, M925A2 WWN	332	98	97 [1]	1,827 [2]	94	1,770
M927	389	98	94 [1]	2,074 [2]	91	2,008
M927A1, M925A2	386	98	97 [1]	2,124 [2]	94	2,058
M928 WWN	402	98	94 [1]	2,143 [2]	91	2,075
M928A1, M928A1 WWN	408	98	97 [1]	2,245 [2]	94	2,175
Bridge Transporter	373	116	116 [1,5]	1,905 [2,5]	(1, 5)	(2, 5)
10-ton:						
M977 WOWN, M977 WWN	401	96	(8)	(4)	101 [3]	2,268 [3]
M985 WOWN, M985 WWN	401	101	(8)	(4)	101 [3]	2,268 [3]

[1] For height over bows or top of cab shield, use operational height of vehicle listed in TB 55-46-1.
[2] For shipping cube over side rack/bows and/or top of cab shield, use operational cube of vehicle listed in TB 55-46-1.
[3] Height and cube measured to top of cab.
[4] See Top of Steering Wheel column for cube.
[5] Height and cube measured to top of bulkhead.
[6] Cube capacity over materials-handling crane mounted in body.
[7] Height over spare tire.
[8] Steering wheel is higher than side panels. See Top of Steering Wheel column for height.

Table 3-15. Shipping dimensions and cube for dump trucks

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	TOP OF STEERING WHEEL Height (in)	TOP OF STEERING WHEEL Cube (cu ft)	TOP OF SIDE PANELS Height (in)	TOP OF SIDE PANELS Cube (cu ft)
2 1/2-ton:						
M342A2	261	96	(1, 2)	(3, 4)	83 [5]	1,204 [4,6]
M342A2 WWN	273	96	(1, 2)	(3, 4)	83 [5]	1,259 [4,6]
5-ton:						
M51, M51A1, M51A2	266	98	(1, 2)	(3, 4)	89 [5]	1,337 [4,6]
M51 WWN, M51A1 WWN, M51A2 WWN	282	98	(1, 2)	(3, 4)	89 [5]	1,415 [4,6]
M817	274	98	(1, 2)	(3, 4)	91 [5]	1,411 [4,6]
M817 WWN	289	98	(1, 2)	(3, 4)	91 [5]	1,488 [4,6]
M929	275	98	(1, 2)	(3, 4)	91 [5]	1,420 [4,6]
M930 WWN	289	98	(1, 2)	(3, 4)	91 [5]	1,492 [4,6]
20-ton:						
F5070	313	103	(2)	(3, 4)	125 [5]	2,333 [4,6]
M917	351	98	(2)	(3, 4)	141 [2]	2,807 [4]

[1] Side panels stowed in cargo body are higher than steering wheel. See Top of Side Panels column for height.
[2] For height over bows or top of cab shield, use operational height of vehicle listed in TB 55-46-1.
[3] See Top of Side Panels column for cube.
[4] For shipping cube over side racks/bows and/or top of cab shield, use operational cube of vehicle listed in TB 55-46-1.
[5] Height of cab shield stowed in dump body.
[6] Cube with cab shield stowed in dump body.

Table 3-16. Shipping dimensions and cube for cargo trailers

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	TOP OF SIDE RACKS Height (in)	TOP OF SIDE RACKS Cube (cu ft)	TOP OF SIDE PANELS Height (in)	TOP OF SIDE PANELS Cube (cu ft)
1/4-ton:						
M100	108	57	NA	NA	43[1]	154[2]
3/4-ton:						
M101A1, M101A2	147	74	65[1]	410[2]	50[1]	315[2]
1 1/2-ton:						
M104A1	166	84	84[1]	678[2]	57[1]	460[2]
M105, M105A1, M105A2	166	83	82[1]	654[2]	55[1]	439[2]

[1] For height over top of cab, use operational height of vehicle listed in TB 55-46-1.
[2] For shipping cube over side racks/bows and/or top of cab shield, use operational cube of vehicle listed in TB 55-46-1.

Table 3-17. Shipping dimensions and cube for stake and platform semitrailers

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	TOP OF SIDE RACKS Height (in)	TOP OF SIDE RACKS Cube (cu ft)	TOP OF SIDE PANELS Height (in)	TOP OF SIDE PANELS Cube (cu ft)
12-ton:						
M127, M127A1	346	98	109	2,107	61	NA
M127A1C	349	98	109	2,144	61	NA
M127A2C	352	98	108	2,145	60	NA
22 1/2-ton:						
M871	358	96	103	2,049	55	NA
M871A2	377	96	103	2,129	55	NA
34-ton:						
M872, M872A1, M872A2	492	96	106	2,898	58	NA
M872A3	493	96	106	2,904	58	NA
40-ton:						
M870	510	96	70	1,984	40	NA
M870A1	505	96	70	1,964	40	NA

Table 3-18. Shipping dimensions and cube for van semitrailers

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	TOP OF VAN Height (in)	TOP OF VAN Cube (cu ft)
12-ton:				
M128	344	97	140	2,712
M128A1	346	97	140	2,720
M128A1C	350	99	143	2,868
M128A2C	347	99	146	2,903

Table 3-19. Shipping dimensions and cube for fuel tankers

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	HEIGHT TOP OF SIDE PANELS (in)	SHIPPING CUBE (cu ft)
M131A4C	374	96	107	2,265
M131A5C	376	96	107	2,236
M967, M969	368	96	105	2,147
M1062	433	97	123	2,990

Table 3-20. Shipping dimensions and cube for heavy equipment transport trailers

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	HEIGHT TOP OF SIDE PANELS (in)	SHIPPING CUBE (cu ft)
M747	513	137	105	4,208
M1000	622	144	144	7,464

Table 3-21. Shipping dimensions and cube for PLS

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	HEIGHT TOP OF SIDE PANELS (in)	SHIPPING CUBE (cu ft)
M1074	431	96	127	3,050
M1075	431	96	128	3,065
M1076	299	96	117	1944

Table 3-22. Shipping dimensions and cube for FMTV trailers

VEHICLE TYPE	LENGTH (in)	WIDTH (in)	HEIGHT TOP OF SIDE PANELS (in)	SHIPPING CUBE (cu ft)
2 1/2-ton:				
M1082	209	96	58	674
5-ton:				
M1095	220	96	58	709

Table 3-23. Average vehicle stopping distances

SPEED			AVERAGE DISTANCE							
MPH	KPH	ft/sec	Perception (ft)	Perception (m)	Reaction (ft)	Reaction (m)	Braking (ft)	Braking (m)	Total [1] (ft)	Total [1] (m)
Passenger vehicles [2]:										
20*	32.2	29.3	22	6.7	22	6.7	25	7.6	69	21.0
25*	40.3	36.7	28	8.5	28	8.5	35	10.7	91	27.7
30*	48.3	44.0	33	10.0	33	10.0	48	14.6	114	34.6
35*	56.3	51.3	39	11.9	39	11.9	67	20.4	145	44.2
40*	64.4	58.7	44	13.4	44	13.4	90	27.4	178	54.2
45*	72.4	66.0	50	15.3	50	15.3	117	35.7	217	66.3
50*	80.5	73.4	55	16.8	55	16.8	148	45.2	258	78.8
55	88.5	80.7	61	18.6	61	18.6	185	56.4	307	93.6
60	96.6	88.0	66	20.1	66	20.1	228	69.6	360	109.8
65	104.6	95.4	72	21.9	72	21.9	275	83.9	419	127.7
70	112.6	102.7	77	23.5	77	23.5	332	102.5	486	149.5

Table 3-23. Average vehicle stopping distances (continued)

SPEED			AVERAGE DISTANCE							
MPH	KPH	ft/sec	Perception		Reaction		Braking		Total [1]	
			(ft)	(m)	(ft)	(m)	(ft)	(m)	(ft)	(m)
Single-unit vehicles (gross weight less than 10,000 pounds):										
20*	32.2	29.3	22	6.7	22	6.7	30	9.2	74	22.6
25*	40.3	36.7	28	8.5	28	8.5	42	12.8	98	29.8
30*	43.3	44.0	33	10.0	33	10.0	58	17.7	124	37.7
35*	56.3	51.3	39	11.9	39	11.9	80	24.4	158	48.2
40*	64.4	58.7	44	13.4	44	13.4	106	31.4	194	58.2
45*	72.4	66.0	50	15.3	50	15.3	138	42.1	238	72.7
50	80.5	73.4	55	16.8	55	16.8	177	54.0	287	87.6
55	88.5	80.7	61	18.6	61	18.6	222	67.5	344	104.7
60	96.6	88.0	66	20.1	66	20.1	273	83.3	405	123.5
Single-unit, two-axle vehicles (gross weight of 10,000 pounds or more):										
20*	32.2	29.3	22	6.7	22	6.7	40	12.2	84	25.6
25*	40.3	36.7	28	8.5	28	8.5	64	19.5	120	36.5
30	48.3	44.0	33	10.0	33	10.0	92	28.0	158	48.0
35	56.3	51.3	39	11.9	39	11.9	126	38.4	204	62.2
40	64.4	58.7	44	13.4	44	13.4	165	50.3	253	77.1
45	72.4	66.0	50	15.3	50	15.3	208	63.4	308	94.0
50	80.5	73.4	55	16.8	55	16.8	256	78.1	366	111.7
55	88.5	80.7	61	18.6	61	18.6	310	94.5	432	131.7
60	96.6	88.0	66	20.1	66	20.1	372	113.5	504	153.7
Single-unit, multiaxle vehicles and combination vehicles [3] (gross weight of 10,000 pounds or more):										
20*	32.2	29.3	22	6.7	22	6.7	50	15.3	94	28.7
25	40.3	36.7	28	8.5	28	8.5	80	24.4	136	41.1
30	48.3	44.0	33	10.0	33	10.0	115	35.1	181	55.1
35	56.3	51.3	39	11.9	39	11.9	157	47.9	235	71.7
40	64.4	58.7	44	13.4	44	13.4	205	62.5	293	89.3
45	72.4	66.0	50	15.3	50	15.3	260	79.3	360	109.9
50	80.5	73.4	55	16.8	55	16.8	320	97.6	430	131.2
55	88.5	80.7	61	18.6	61	18.6	388	118.3	510	155.5
60	96.6	88.0	66	20.1	66	20.1	465	141.9	597	182.1

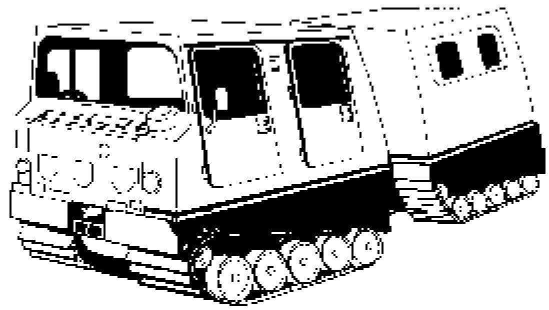
[1] Add 30 feet or 9 meters to each total stopping distance shown to determine actual gap to use between vehicles.

[2] Does not include buses. Refer to section with weights and axles corresponding to buses.

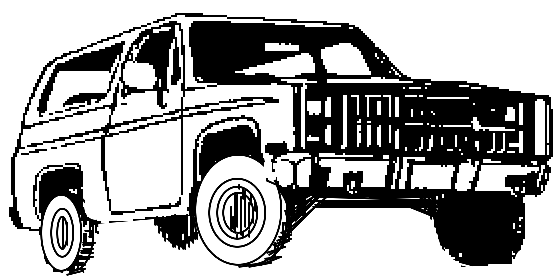
[3] Tractor trucks, semitrailers, and trailers.

* Rule of thumb method may be used at this speed.

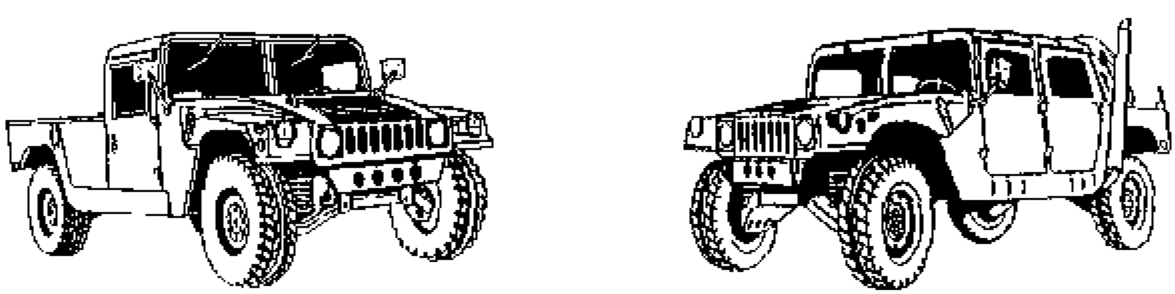
LIGHT FLEET



M973, 1 1/2-TON, SUSV



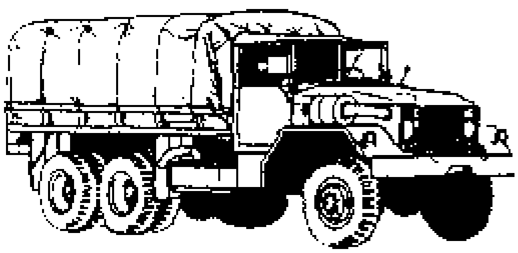
M1009, 4 X 4, 3/4-TON, CUCV



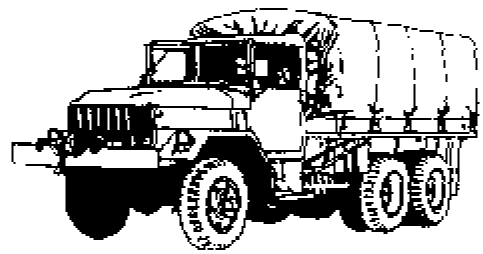
M1038, 1 1/2-TON, HMMWV

Figure 3-23. Army motor transport vehicles

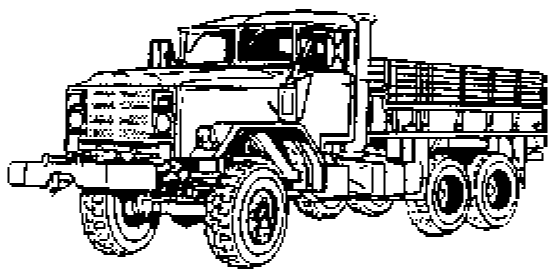
MEDIUM FLEET



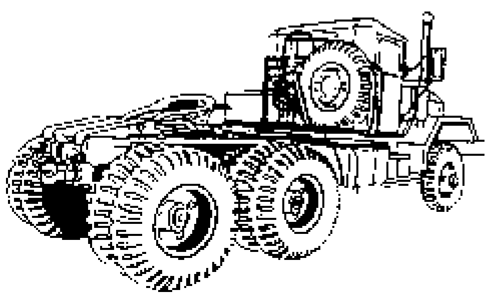
M813, 5-TON, TRUCK-CARGO



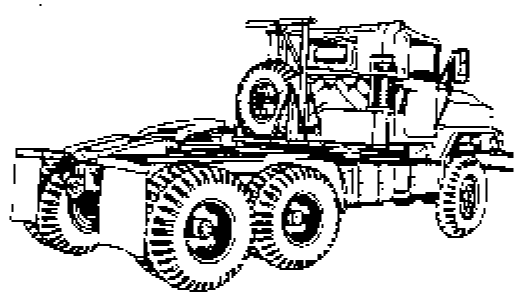
M35A2, 2 1/2-TON, TRUCK-CARGO



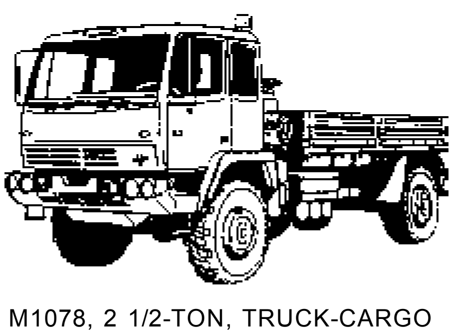
M923A2, 5-TON, TRUCK-CARGO



M818, 5-TON, TRUCK-TRACTOR



M931, 5-TON, TRUCK-TRACTOR

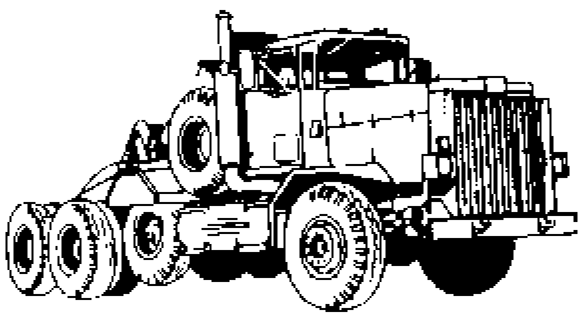


M1078, 2 1/2-TON, TRUCK-CARGO
(LMTV)

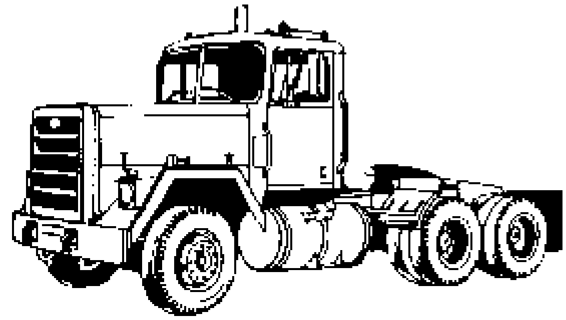
M1084, 5-TON, TRUCK-CARGO
(MEDIUM TACTICAL VEHICLE)

Figure 3-23. Army motor transport vehicles (continued)

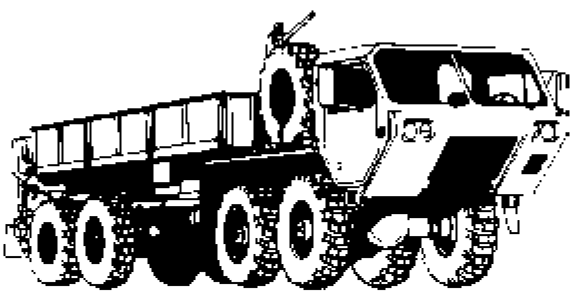
HEAVY FLEET



M911, 8 X 6, 60-TON, TRUCK-TRACTOR
(CHET)

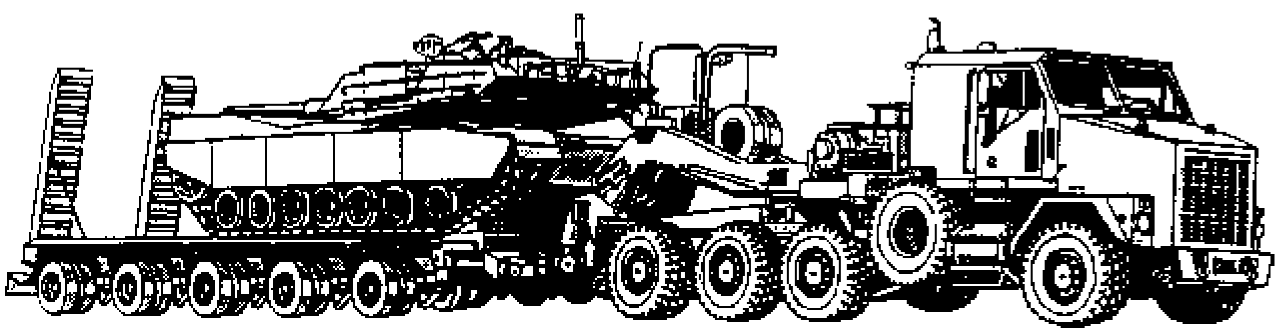


M915, 6 X 4, TRACTOR-LINE-HAUL



M977, 8 X 8, 10-TON, TRUCK-CARGO
(HEMTT)

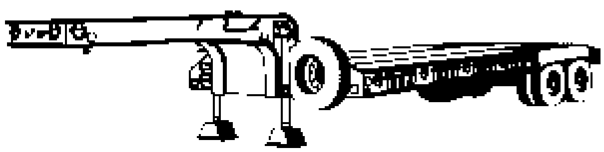
M1070, 8 X 8, 22 1/2-TON, TRUCK-TRACTOR
(HET)



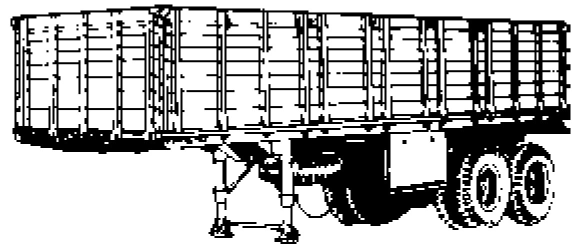
M1070, TRUCK-TRACTOR/M-1000, 70-TON, SEMITRAILER
(HET)

Figure 3-23. Army motor transport vehicles (continued)

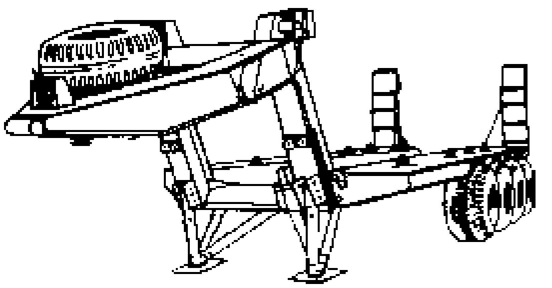
TRAILERS



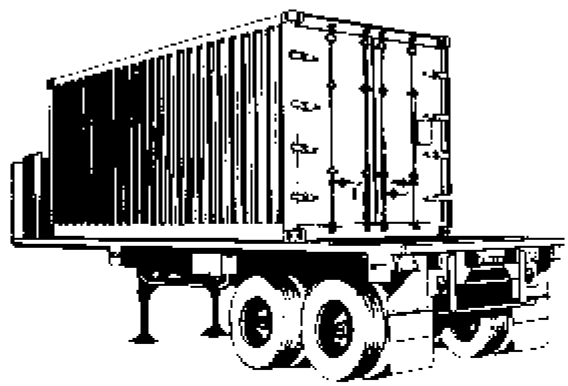
M172A1, 4 X 4, 25-TON, SEMITRAILER, LOW-BED



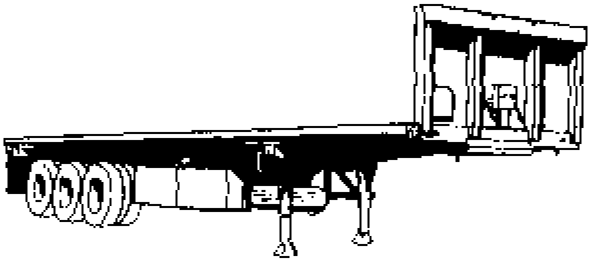
M127A2, 4 X 4, 12-TON, SEMITRAILER, STAKE



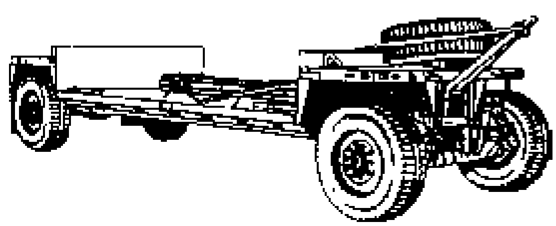
M747, 8 X 8, 60-TON, SEMITRAILER (HET)



M871, 4 X 4, 22 1/2-TON, SEMITRAILER, LOW-BED, BREAK-BULK/CONTAINER TRANSPORTER



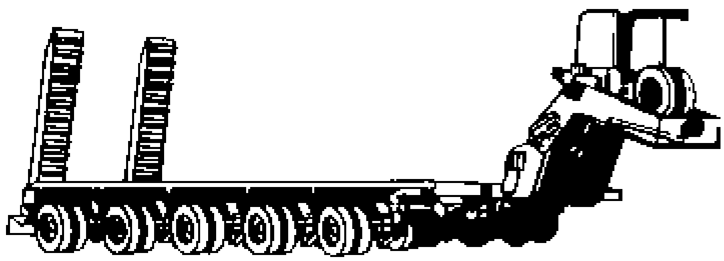
M872, 6 X 6, 34-TON, SEMITRAILER, FLAT-BED, DUAL-PURPOSE BREAK-BULK/CONTAINER TRANSPORTER



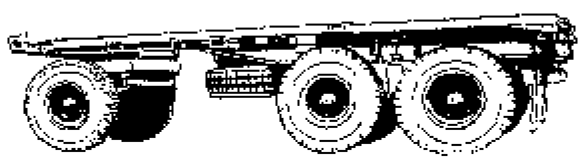
M989A1, 11-TON, TRAILER, FLATBED (HEMAT)

Figure 3-23. Army motor transport vehicles (continued)

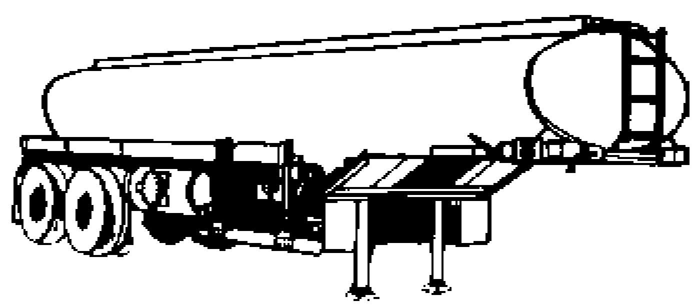
TRAILERS



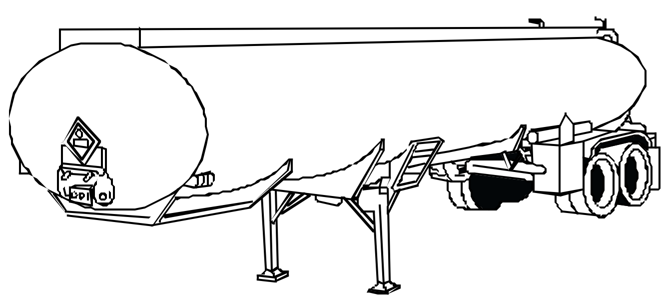
M1000, 8 X 8, 70-TON, SEMITRAILER (HET)



M1076, 16.5-TON, TRAILER (PLS)



M131A5C, 4 X 4, 5,000-GALLON, SEMITRAILER, TANK, FUEL



M1062, 4 X 4, 7,500-GALLON, SEMITRAILER, TANK, FUEL

Figure 3-23. Army motor transport vehicles (continued)

CHAPTER 4
RAIL TRANSPORT

This chapter covers the various aspects and phases of military rail operations as they pertain to CONUS and the overseas theater.

Section I
ORGANIZATION AND OPERATIONS

RAILWAY UNITS

The term "transportation railway service" applies to railway units assigned or attached to a major transportation organization, normally a transportation composite group or a transportation command. The TRS includes supervisory, operating, and maintenance units. These units operate trains, maintain rail lines of communication and trackage, and perform direct support and general support maintenance on locomotives and rolling stock. Depending on the extent of the operation, any TRS supervisory unit may perform staff and planning functions and serve as the highest echelon of military railway service in a theater.

See Appendix A for a listing of railway units according to TOE, mission, assignment, and capability. See FM 55-20 for a detailed discussion of these units.

ADMINISTRATION

Military railway operations are accomplished in three phases. The purpose of these phases is to reduce requirements for military units and personnel, as follows:

- Phase I – Military railway personnel conduct operations exclusively.
- Phase II – Military railway personnel operate and maintain railway lines, augmented and assisted by local civilian railway personnel.
- Phase III – LN civilian railway personnel operate and maintain railway lines. The highest military railway echelon in the theater directs and supervises operations. This arrangement releases unit railway personnel for other duties and begins whenever local conditions permit.

Generally, these phases are conducted in sequence. Sequence may vary, however, depending on military requirements. A phase II or phase III operation may be initiated without progressing through or regressing to previous phases.

For sample SOP formats for rail movements and the transportation railway service, see Figure 4-1, page 4-2, and Figure 4-2, page 4-3.

OPERATIONS PLANNING

A number of factors should be considered when planning the most effective use of a railway system. Among the most important are line length and location and capacity of yards. Others include:

- Roadbed and track condition.
- Track gauge.
- Track type (single, double, or multiple).
- Rail weight.
- Ballast type and depth.
- Tie type (if wood, treated or untreated).

- Tie spacing.
- Axle load limitations (track and bridge).
- Line profile showing location and length of ruling grade.
- Line alignment showing location and length of minimum-radius curves.
- Location and description of bridges and tunnels.
- Location and length of passing tracks.
- Location, type, and quantity of fuel supply.
- Location, quantity, and quality of water supply.
- Location and capacity of car repair shops and enginehouses.
- Type and availability of motive power, i.e., diesel electric, electric, steam (weight in working order, expected working tractive effort, drawbar pull, and age).
- Type and availability of rolling stock (capacity, dimensions, and age).
- Climatic and prevailing weather conditions.
- Diagrams showing minimum structure, maximum unrestricted loading, and equipment gauges.
- Signal system (wire and radio requirements and coordinating responsibilities).
- Dispatching facilities.
- Route junctions.
- Availability of new equipment and repair parts.
- Local labor resources.

Because the direction of military movements is primarily forward, military rail line capacity estimates are usually based on net tonnage moved in one direction. The movement of trains in both directions must also be considered since total capacity is based on train density. When the railway net includes several divisions and branch lines, separate estimates should be made for each. When estimating rail line payload capacity, power (locomotive) and resistance (rolling, curve, and weather) are the limiting factors. The following factors and formulas should be used in the order listed.

(Classification)

STANDING OPERATING PROCEDURE

1. GENERAL. Policies and factors involved in selecting and carrying out railway movements.

2. SUPPLY MOVEMENTS
   a. Releases. Date required, procurement methods, formats, dissemination, action required.
   b. Routing. Responsibilities and procedures.
   c. Diversions and reconsignments. Authority and initiating procedures for method used.
   d. Records and reports. Responsibilities and methods for maintaining specific reports and appropriate references to reports.

3. TROOP MOVEMENTS
   a. Current situation (for example, war, peace, partial or full mobilization, civil unrest).
   b. Distance to be traveled.
   c. Origin and destination points.
   d. Security requirements.
   e. Tactical situation.
   f. Types and amount of equipment available.
   g. Priority.

(Classification)

Figure 4-1. Sample format for rail movements SOP

(Classification)

STANDING OPERATING PROCEDURE

1. GENERAL
   a. Rail transportation integration in the theater transportation net.
   b. Operational control.
   c. Coordination with adjacent commands for rail use and support of operating units.
   d. Coordination of the theater rail plan for selection, rehabilitation, and operation of rail line to support theater strategic plans.

2. MISSION. Rail net and facilities operated; terminals, installations, and commands supported.

3. ORGANIZATION. Available operating units, location, and operating limits.

4. FUNCTIONS. Responsibilities for operation and maintenance of military railways and equipment, as well as for freight, passenger, and special trains.

5. PLANNING

   a. Long-Range.
      (1) Responsibilities and procedures.
      (2) Primary and alternate rail routes selection.
      (3) Line capacity, troop equipment, and supply requirements.
      (4) Rehabilitation and projected requirement.
      (5) Communication and security requirements.
      (6) Demolition plans.
   b. Short-Range.
      (1) Current operational plans.
      (2) Current rail line capacity and requirements.
      (3) Phases of operation.
      (4) Selection and rehabilitation of new or additional facilities.

6. OPERATIONS

   a. Disseminating and implementing movement programs.
   b. Coordinating with the transportation movements officer.
   c. Setting priorities for rail equipment and its use.
   d. Preparing and compiling operational and situation reports.
   e. Ordering cars and documenting their use.
   f. Scheduling special trains.
   g. Assisting in construction and placing of railcar spanners.
   h. Inspecting loaded cars.

7. MAINTENANCE. Responsibilities, procedures, inspections, reports, and standards for maintaining military and utility railway facilities and equipment.

8. SUPPLY. Responsibilities and procedures for requisitioning, stocking, distributing, maintaining levels of, disposing of excess, and accounting for railway operating and maintenance supplies; requirements and priorities for major items, including locomotives and rolling stock.

Figure 4-2. Sample format for transportation railway service SOP

9. INTELLIGENCE AND RECONNAISSANCE. Responsibilities and procedures for collecting, processing, disseminating, and using intelligence.

10. SECURITY. Procedures, responsibilities, and coordination of security requirements for trains and rail line-of-communication facilities, defense and demolition plans, and supplies en route by rail.

11. RECORDS AND REPORTS. Responsibilities and procedures for records and reports of railway operations, situation, personnel status, equipment maintenance and inspection, equipment status, and projected status.

12. TRAINING. Responsibility for conducting unit and technical training.

____
(Classification)

Figure 4-2. Sample format for transportation railway service SOP (continued)

Weight on Drivers

The weight on drivers of a locomotive is that weight supported by the driving (powered) wheels when they rest on a straight and level track. Weight on drivers does not include any of the remaining portion of the locomotive's weight.

Weight on drivers is expressed in STONs. Different types and classes of locomotives differ in weight. All locomotives are constructed to specifications issued by the purchaser, the using railroad, or the manufacturer. See Table 4-1, page 4-5, for the weight on drivers of some common types of diesel-electric locomotives used by the Army. See FM 55-20 for a complete breakdown of Army locomotive characteristics.

Tractive Effort

The horizontal force that a locomotive exerts if the wheels do not slip is known as tractive effort. Expressed in pounds, TE measures a locomotive's potential power. The TE is supplied by the locomotive manufacturer. See FM 55-20 for the TEs of Army locomotives. When data is not available, use the formulas that follow to compute TE. Be sure to allow for locomotive age and condition.

Starting TE is the power that a locomotive has available to move itself and its load from a stopped position. Continuous TE is the effort required to keep a train rolling after it has started. As train momentum increases, needed TE diminishes rapidly. In steam locomotives, there is no difference between starting and continuous TE. A steam locomotive can generally continue to pull what it can start. However, a diesel-electric locomotive cannot continue to exert the same force achieved in starting without damaging its power unit. The continuous TE of a diesel-electric locomotive is about 50 percent of its starting TE.

Starting TE corresponds to the adhesion of the driving wheels to the rails. If the TE expended exceeds this adhesion element, the drivers will slip. Normally, the adhesion element is 30 percent of the weight on drivers for dry rails and 20 percent for wet rails for an average of 25 percent. The estimated starting TE for a locomotive is, therefore, 25 percent of its weight on drivers.

For an 80-ton (160,000-pound) locomotive on drivers:

Starting TE = 25% x 160,000 lb = 40,000 lb

For a steam locomotive with starting TE of 40,000 pounds:

Continuous TE = Starting TE = 40,000 lb

For a diesel-electric locomotive with starting TE of 40,000 pounds:

Continuous TE = 50% x 40,000 lb = 20,000 lb

Drawbar Pull

Drawbar pull is the pulling ability of a locomotive less the effort needed to move the locomotive. Tests have shown that 16 to 20 pounds of pull per ton are needed to start the average locomotive or freight car on straight, level track under favorable weather and temperature conditions. A locomotive or car having roller bearings will start with somewhat less effort.

For railway planning, use 20 pounds per ton. Resistance drops after equipment starts rolling. However, to establish pulling ability (drawbar pull) available for starting and pulling a train, subtract 20 pounds per ton of locomotive weight from the continuous TE of the locomotive. A diesel-electric locomotive having a weight on drivers of 80 tons and a continuous TE of 20,000 pounds has a drawbar pull of 18,400 pounds (20,000 pounds minus 1,600 pounds).

Maximum drawbar pull is exerted only at very low speeds – up to about 10 MPH – after which it drops off sharply. To obtain drawbar pull at given speeds, apply a speed factor to the maximum drawbar pull. Remember that speeds differ for different types of locomotives. For one type of steam locomotive, drawbar pull was found to diminish in inverse ratio to speed: drawbar pull was 80 percent at 20 MPH, 50 percent at 50 MPH, and 20 percent at 80 MPH. Use this inverse ratio as a rule of thumb for estimating drawbar pull of steam locomotives at various speeds. Drawbar pull diminishes more rapidly at higher speeds for diesel-electric locomotives than for steam locomotives.

Resistance Factors

Certain forces, known as resistance factors, impact on a train's operational capability and efficiency. These forces hold or retard movement. Each resistance must be factored to determine locomotive power and the total tonnage that can be handled over certain tracks at a given time.

Rolling resistance. Rolling resistance includes the forces that act on a train in a direction parallel to the track. Components of rolling resistance include friction between the railheads and the wheel treads and flanges, undulation of track under a moving train, internal friction of rolling stock, and resistance in still air. There is no absolute figure to use for rolling resistance. However, experience has led to safe average values for rolling resistance in the theater of operations. These values are shown in Table 4-2.

Grade resistance. Grade resistance is 20 pounds times the percent of grade (20 x % grade).

Curve resistance. No entirely satisfactory theoretical discussion of curve resistance has been published. However, engineers in the United States usually allow from 0.8 to 1 pound per degree of curve. Military railway planning allows 0.8 pound per degree of curve.

Table 4-1. Weight on drivers of diesel-electric locomotives

LOCOMOTIVE TYPE	WEIGHT ON DRIVERS (STON s)	HP
Multigauge, 0-6-6-0	120	1,600
Standard gauge, 0-4-4-0	60	500

Table 4-2. Average values for rolling resistance

AVERAGE VALUE	TRACK CONDITION
5	Excellent
6	Good to fair
7	Fair to poor
8	Poor
9-10	Very poor

Weather resistance. Experience and tests show that below-freezing temperatures diminish the hauling power of locomotives. Table 4-3 shows the adverse effects of lower temperatures in percentages of hauling power loss.

Wet weather is usually considered local and temporary and may be disregarded in normal planning. In countries with extended wet seasons, however, loss of TE due to slippery rails may prove serious if sanding is inadequate. The applicable reduction in TE is a matter of judgment. In general, TE will not be less than 20 percent of weight on drivers.

Gross Trailing Load

GTL is the maximum tonnage that a locomotive can move under given conditions, such as curvature, grade, and weather. Determine GTL by combining all the factors discussed in the preceding paragraphs. Use the following formula to calculate GTL:

$$GTL = \frac{DBP \times WF}{RR + GR + CR}$$

where GTL = gross trailing load
DBP = drawbar pull
W = weather resistance
RR = rolling resistance
GR = grade resistance
CR = curve resistance

When using two steam locomotives (either double-heading them or having one pull and the other push), find GTL by taking 90 percent of the total GTL of both locomotives. The 90 percent figure is based on the difficulty in perfectly coordinating the actions of two locomotive operators. However, when diesel-electric locomotives are used in multiple-unit operation, the GTL will be 100 percent of the total GTL for both locomotives since they are operated by one person from a single control.

Net Trainload

NTL is the payload carried by the train. NTL is the difference between gross weight (total weight of cars under load) and tare weight (total weight of cars empty). In military railway planning:

$$NTL = 50\% \times GTL$$

Train Density

The number of trains that may be safely operated over a division in each direction during a 24-hour period is known as train density. Work trains are not included when computing TD. However, work trains blocking the main track can reduce the density of a rail division. Factors affecting TD include–

- Condition and length of the main line.
- Number and location of passing tracks.
- Yard and terminal facilities.
- Train movement control facilities and procedures.
- Availability of train crews, motive power, and rolling stock.

On a single track line, passing tracks are normally 6 to 8 miles apart. Multiple tracks (three or more) are generally considered double track lines for planning purposes since it is often necessary to remove a portion of the third and fourth tracks to maintain the double-track line.

Table 4-3. Effects of temperature in percent of hauling power loss

TEMPERATURE (°F)	LOSS IN HAULING POWER (%)
Above +32	0
+31 to +16	5
+15 to 0	10
–1 to –10	15
–11 to –20	20
–21 to –25	25
–26 to –30	30
–31 to –35	35
–36 to –40	40
–41 to –45	45
–46 to –50	50

The capacity and turnover of cars and trains operating in and out of terminal yards must be considered, either from definite experience and intelligence factors or by inference from other related information. Use the formulas that follow to find reasonably accurate estimates of freight TD for lines with 20 percent passenger trains. For a single-track operation, use this formula:

$$TD = \frac{(NT + 1)}{2} \times \frac{24 \times S}{LD}$$

where TD = train density
NT = number of passing tracks
1 = constant (number of trains that could be run if there were no passing tracks)
2 = constant to convert to one direction
24 = constant (number of hours per day)
S = average speed (FM 55-20)
LD = length of division

When determining the number of passing tracks, do not include those less than 5 miles apart. The passing tracks selected should be uniformly spaced throughout the division.

Double-track operations must be fluid and flexible. The number of trains in operation should not exceed the number of trains that could be cleared from either main track onto a side or passing track at any time in an emergency. Use the factors given for single tracks to find double track TD (TD2):

$$TD = \frac{(NT + l)}{LD} \times 24 \times S$$

If there is not enough information available to evaluate the potential TD of a rail line, use a TD of 10 for single track and 15 for double track.

Tonnage

Net division tonnage is the payload tonnage in STONs that can be moved over a railway division (90 to 150 miles) each day. NDT includes railway operating supplies; these supplies must be programmed for movement just as the supplies of any other service. To determine NDT, multiply the NTL by the TD of the particular division. Compute NDT separately for each railway division.

There are other factors to consider when calculating NDT. For example, troop, passenger, or hospital trains will replace an equal number of tonnage (cars with loads) freight trains. When the operation of such trains is expected, make allowance in NDT estimates by adjusting the TDs of the divisions concerned. In military operations, end-delivery tonnage is that tonnage (in STONs) delivered at the end of the railway line (railhead) each day. In all rail movements, end delivery tonnage is the same as the NDT of the most restrictive division.

EQUIPMENT REQUIREMENTS

The availability of equipment in liberated or occupied territory depends on many factors including inventories, equipment condition and extent of destruction, types of fuel available, local availability of repair parts, and types of coupling devices.

Rolling Stock

There are several types of railcars. Each has its own capabilities, and each is designed to transport different types of military equipment. The commodity to be moved dictates the type of car that will be used.

Freight cars. Compute requirements separately for operations between major supply installations and areas on each line of communication:

$$\text{number of cars} = \frac{\text{daily tonnage}}{\text{average tons per car}} \times \text{turnaround time} \times 1.10$$

Use these average planning factors for net load per car:

	Standard/Broad Gauge Track (tons)	Narrow Gauge Track (tons)
US Equipment	20	15
Foreign Equipment	10	7.5

Turnaround time is the estimated total number of days required for a car to complete a round trip – the time from placement for loading at point of origin to destination and back. Allow 2 days at origin, 1 day at destination, and 2 days transit time for each division, or major part of a division, which the cars must cross. Use this method rather than an actual hour basis to incorporate delays caused by terminal and way station switching and in-transit rehandling of trains. See Table 4-4 for required dispatch times.

Tank cars. Compute tank car requirements separately based on bulk POL requirements and turnaround time. Tank cars are computed at their full rated capacity.

Passenger cars. Passenger car requirements vary, depending on policies for troop movement, evacuation, and rest and recuperation. Theater passenger car requirements are met with local equipment.

Road locomotives. Use the following formula to determine the number of road locomotives required for operation over a given railway division:

$$\text{locomotives} = TD \times \frac{(RT+TT)}{24} \times 2 \times 1.20$$

where TD = train density
RT = running time (length of division divided by average speed)
TT = terminal time (time for servicing and turning locomotive)
24 = number of hours per day
2 = constant for two-way traffic
1.20 = constant allowing 20 percent reserve

"RT + TT" (i.e., the locomotive factor) is the percentage of time during a 24-hour period that a road locomotive is in use. The locomotive factor provides for the pooled use of motive power which may make one or more trips per day over a short division. Estimates of downtime at terminals are 8 hours for steam locomotives and 3 hours for diesel-electric locomotives.

Switch engines. The number of switch engines required at a terminal is based on the number of cars dispatched, received, or passed through the terminal each day. To allow for maintenance and operational peaks, add 20 percent to the total number of switch engines required for the railway line.

See FM 55-20 for the formula for computing switch engine requirements.

Average Speed

For planning purposes, use the data in Table 4-5 to estimate average speed values. Select the most restrictive factor of the eight factors shown. If the restrictive factor is not known, use an average speed value of 8 MPH (13 KPH) for single track and 10 MPH (16 KPH) for double track. If the most restrictive factor affects only a comparatively short distance (10 percent or less) of the division, use the next higher average speed. If the average speed falls below 6 MPH (10 KPH) because of the gradient, reduce tonnage to increase speed. (A 2 percent reduction in gross tonnage increases speed by 1 MPH.) If the ruling grade materially affects tonnage, consider using helper service.

Table 4-4. Required dispatch times

LOCATION OR TYPE OF OPERATION	DISPATCH TIME (Days)
At base of operation	2
Forward traffic	1 per division
Return traffic	1 per division
At railhead	1

Table 4-5. Impact of restrictive factors on average track speeds

RESTRICTIVE FACTORS	AVERAGE SPEED Single Track MPH	KPH	Double Track MPH	KPH
Condition of Track				
Exceptionally good	12	19.3	14	22.5
Good to fair	10	16.1	12	19.3
Fair to poor	8	12.9	10	16.1
Poor	6	9.6	8	12.9
Grade %				
1 or less	12	19.3	14	22.5
1 to 1.5	10	16.1	12	19.3
1.5 to 2.5	8	12.9	10	16.1
2.5 to 3	6	9.6	8	12.9

LOADING

Many factors must be considered when selecting flat or open-top railcars, to include compliance with CONUS commercial loading rules.

Open-Top Cars

Military equipment loaded on DOD-owned cars traveling on common carrier lines in CONUS must meet the loading standards of both the carrier and the AAR. This requirement also applies to military equipment loaded on common carrier cars. Loads on foreign railroads must meet the country's blocking and lashing standards. STANAGs govern the loading of military equipment on NATO rail lines. The AAR's General Rules Governing the Loading of Commodities on Open-Top Cars (Section 6) is on file at all ITOs in CONUS and is reprinted in TM 55-2200-001-12 as Change 3. Also see Change 4 of this TM for more on loading standards.

Explosives and Other Hazardous Materials

Besides complying with applicable loading rules, personnel must adhere to laws and regulations governing HAZMAT.

Regulations, rules, and guidelines. The DOT is responsible for regulating interstate shipment and movement of all HAZMAT by rail. The US Code (Section 831 through 835, Title 18, Chapter 39) establishes DOT authority and responsibilities for handling and transporting HAZMAT. Applicable regulations are published in 49 CFR, Transportation, and reprinted in BOE Tariff 6000. These regulations set forth requirements for classifying, packaging, marking, labeling, and storing HAZMAT. They also ensure compatibility of materials and govern the placarding of containers and vehicles carrying these materials. (See Appendix E of this manual for DOT Chart 10, Hazardous Materials Marking, Labeling & Placarding Guide.) When necessary, DOD and DA may supplement DOT requirements. For more specific regulations and guidance, see the following publications:

- AR 55-355 covers transporting military explosives and HAZMAT by military or commercial carriers within CONUS. It lists AAR loading rules for safe transportation and provides information on placarding containers and vehicles. AR 55-355 requires compliance with all regulations including:
  - Reporting accidents (according to AR 385-40).
  - Maintaining records.
  - Tracing shipments.
  - Completing SF 361.
  - Ensuring cargo security.
- AR 385-40 contains information on reporting accidents.
- MIL-STD-129 series provides guidance on marking packages.
- Bureau of Explosives Pamphlet 6C covers loading and bracing methods. Approval by the AAR of all loading, blocking, and bracing methods used in rail shipment of unboxed explosive projectiles, torpedoes, mines, and bombs exceeding 90 pounds is required by 49 CFR, Paragraph 173-56. Only the military is authorized to ship palletized explosive projectiles of not less than 4 1/2 inches in diameter without being boxed. Methods for bracing and blocking other than those given in this pamphlet must be submitted through military transportation channels to the BOE for approval.
- TM 9-1300-206 provides information on the care, preservation, and destruction of ammunition. It contains data on quantity-distance standards for manufacturing, storing, and transporting mass-detonating ammunition, handling, explosives, and small arms ammunition. It also includes quantity-distance classes and tables for all classes of ammunition and explosives.
- TM 55-602 offers general guidance on transporting special freight. It identifies applicable directives and regulations and agencies prescribing transportation policies.
- Army Materiel Command publications contain outloading drawings of ammunition, missile systems, special weapons, and other HAZMAT.

Bracing and blocking. When bracing and blocking, only lumber free of characteristics that impair strength or interfere with proper nailing should be used. Do not use lumber with cross grain, knots, knotholes, cracks, or splits. Use nails IAW TM 55-2200-001-12. Nails should be long enough to ensure necessary holding power and ample penetration of car walls, floors, or bracing and blocking materials. To prevent sparks when nailing braces around packages of explosives, brass or copper hammers should be used. Drive nails holding sidewall blocking into the heavy uprights supporting the car lining. Car lining is only three-quarters or seven-eighths of an inch thick and has little holding power for large nails.

Basic precautions. Basic precautions should be followed when loading a railcar. For example, avoid placing a large shipment in one end of a car. Do not load a shipment exceeding 12,000 pounds in one end of a car unless freight will be loaded to balance the other end. Failure to observe this precaution may cause the car to derail. Never load or stow incompatible chemicals or explosives together (see 49 CFR, Parts 170 through 179). Added precautions include the following:

- When loading packages, avoid losing space by pressing each package firmly toward the end of the car.
- Avoid high pressure on small areas. Use the largest possible area of a package to resist pressures. Nail beveled boards to cover projecting metal or nails or other defects in the floor. Cars with corrugated or pressed metal unlined ends, as well as cars with bowed ends, must be boarded up at the inside of the ends to the height of the load.
- Never use cars with end doors or cars with automobile loading devices (unless the loading device is attached to the roof of the car so that it cannot fall – applicable to shipment of Class A explosives only).
- Never use refrigerated cars unless use is authorized by the carrier or owner, ice bunkers are protected by solid bracing, and nonfixed floor racks are removed.
- When loading in closed cars, secure the load so that it does not come into contact with side doors or roll and shift in-transit.
- When using lift trucks to move heavy loads in and out of cars, use a temporary steel plate or other floor protection device of suitable size to prevent the truck from breaking through the floor. Place the load in the car so that there is no more weight on one side than the other. Limit the load over truck assembly to half the load limit stenciled on the car. Cars should be loaded as heavily as possible up to the load limit stenciled on the car.
- When loading between truck centers and the ends of the car, material must not exceed 30 percent of the stenciled load limit (15 percent each end) when both ends are loaded and 10 percent when only one end is loaded. For specific guidance, refer to the General Rules section of TM 55-2200-001-12.
- When loading, blocking, and bracing ammunition for carload and less-than-carload shipments, make sure ammunition containers are tightly wedged in place at the time of loading. Bulkhead braces for partial layers must be long enough to permit nailing to upright braces behind car lining. Length will vary, depending on weight of lading supported. The filler strips nailed to the sides of the car must be extended across the doorway. No other doorway protection is required.

Dangerous cargo placards. On loaded cars, labels and placards are required for both the containers and railcars carrying explosives and other HAZMAT. For a description of labels and other placards, see 49 CFR, Parts 172 through 174, and Appendix E of this manual.

Empty tank cars and boxcars are often covered with notices warning of lingering gases and fumes. These warning cards stress that care must be used in switching the cars as well as in unloading their contents.

Cargo Security

The rail transportation industry and the shipper share responsibility for cargo security.

At origin. The shipper is responsible for the security of carload freight until the car is coupled to a locomotive or train for movement. The shipper must be fully aware of this responsibility, which includes the following:

• Thoroughly inspecting the car before loading to ensure that it meets security and serviceability requirements. Cars with insecure doors or holes or damaged places in floors, roofs, or sides must be repaired before they are used or rejected to carrier and a substitute car provided.

• Properly loading and bracing the load and closing and sealing the car. Improperly stowed or braced loads may be damaged in movement, inviting pilferage. (See Change 4, TM 55-2200-001-12).

• Conforming to the loading standards necessary for safe movement under existing conditions.

– Sealing closed cars containing sensitive AA&E cargo with cable seal locks. If these locks are not available, use a Number 5 steel wire twist or a wire cable of larger or equivalent thickness, together with a ball-type, serialized seal to secure door hasps.

– Ensuring that shipping papers furnished the carrier specify that flame or heat-producing tools will not be used to remove sealing devices from AA&E shipments. For nonsensitive shipments other than AA&E, a ball-type, serialized seal will suffice.

– Covering shipments in open cars with securely fastened tarpaulins.

– Fastening small items shipped on flatcars securely to the car floor.

• Preparing an accurate list of contents, preparing the waybill, and affixing placards to the cars. The shipper also transmits/mails an advance notice of AA&E shipments to the consignee. After a car is loaded, sealed, and documented, it should be moved as quickly as possible.

At military installations, the originating transportation officer and commercial railway personnel must inspect all open-top cars before movement to ensure that they are loaded properly and meet clearance requirements.

In-transit. The commercial railroad (CONUS) or the TRS (overseas theaters) is responsible for the security of all in-transit carload freight from the time the car is moved from its loading point until it reaches its designated unloading point.

The originating rail carrier or the TRS prepares all car records, train documents, and other records required to speed movement and prevent loss of cars en route. When possible, cars carrying pilferable freight are grouped together to allow for the economical use of guards. Special handling is given to mail or high-priority classified traffic.

In CONUS, the appropriate Army headquarters provides train guards. In overseas theaters, military police or other units assigned or attached to the TRS for security duties provide train guards. These units also guard cars and trains during movement in railroad yards. Sensitive supplies may be guarded by personnel assigned to the car by the loading agency. The yardmaster notifies the dispatcher on receipt of cars with special guards. The yardmaster also notes receipt on the train consist, which is transmitted to yards and terminals. This notification helps avoid delays in transit and expedites placement at the destination.

Guard crews check car seals and inspect trains for security. They prepare a record, by car number, of all guarded cars in trains and note any deficiencies or incidents en route. When a relief guard takes over, the crews make a joint inspection and then sign the record.

When a "bad-order" car containing supplies subject to pilferage is "set out," a member of the guard crew stays with the car until properly relieved. Guard crews must be alert at all times, particularly when the train is stopped or passing through tunnels, cuts, and villages at slow speeds.

At destination. When carload freight is received by the designated depot, siding, or track, the consignee then becomes responsible for the shipment. Specific guidelines, if observed by the consignee, limit possibilities for loss, pilferage, or serious damage or injury. They include the following:

• Unload cars as quickly as possible.

• When removing wire seals from closed cars, be careful not to break latches on car doors. Wire cutters are recommended for this purpose.

• Record seal numbers on shipping documents.

• Do not use flame or heat-producing tools to remove sealing devices from shipments of arms, ammunition, or explosives.

CONSTRUCTION, MAINTENANCE, AND SUPPLY

The most important assets of a rail network are track and roadbeds. Construction of new trackage is performed by the CofE and general maintenance performed by TRS.

Construction Requirements

For planning purposes, a railroad division includes 90-150 principal route miles of main line single or double track. The division includes terminal operation and maintenance facilities, fueling and watering facilities, and necessary signaling equipment or interlocking facilities. Passing sidings on single-track lines, crossovers on double-track lines, and stations are located at intervals required by traffic. Normally, there is at least one spur or siding provided at each station.

The engineer service in the theater of operations is responsible for new rail construction and large scale rehabilitation. However, TRS maintenance of way personnel may be required to assist engineer personnel with rehabilitation.

See Table 4-6 for the materials and man-hours required for new construction of one mile of standard-gauge (56 1/2-inch), single-track railroad. See Table 4-7, page 4-13, for expected rehabilitation requirements for a 100-mile standard-gauge, single-track division extending inland from a port. This table shows the average percentage of demolition over the entire division. See FM 55-20 and TM 5-370 for more information.

Table 4-6. Material and man-hour requirements for railroad construction*

ITEM	STONs	MTONs	MAN-HOURS
Grading (includes clearing average wooded terrain)	—	—	5,000
Ballast delivered, average haul-5 miles (8.05 km)	—	—	2,500
Tracklaying and surfacing	—	—	3,400
Bridging – 70 linear feet (21.34 m)	128	111	3,200
Culverts, 7 per mile-280 feet (85.34 m)	8	7	1,400
Ties – 2,900	218	300	—
Rail, 90-pound – ARA – A Section	79	45	—
115-pound – ARA – E Section	103	57	—
Fastening (based on 39-foot rail) (11.89 m)	33	10	—
Total	569	530	15,500

* Per 1 mile of standard-gauge single track.

Table 4-7. Rehabilitation requirements per railroad division

ITEM	PER 100 MILES (161 KM)	PERCENT OF DEMOLITION	REHABILITATION (Quantity)	CONSTRUCTION MATERIAL [1] STONs	CONSTRUCTION MATERIAL [1] MTONs	MAN-HOURS [1] (Thousands)
Main line trackage	100 mi	10	7.0 mi	2,708	1,033	36.4
Port trackage[2]	—	100	3.0 mi	1,368	1,092	14.4
Passing sidings[2]	2.4 mi	80	2.4 mi	1,049	874	11.5
Station sidings[2]	1.6 mi	80	1.6 mi	730	582	7.7
Railway terminal [2,3]	1.0 ea	75	0.75 ea	8,025	4,875	160.0
Water stations	3.0 ea	100	3.00 ea	135	210	9.0
Fuel stations	1.0 ea	100	1.00 ea	19	16	0.9
Bridging (70 ft per mile)	7,000	55	2,700 linear ft	2,700	2,672	70.0
Culverts	28,000 linear ft	15	4.200 (74 ea) linear ft	63	63	13.7
Grading and ballast	—	—	—	—	—	40.5

[1] Tunnels require special consideration. To repair (by timbering) a 50-foot demolition at each end of a single-track tunnel (100 ft total per tunnel), allow 70 STONs or 87 MTONs, and 3,000 man-hours.

[2] Estimate includes ties, rails, fastenings, turnouts, tracklaying, and surfacing. It is assumed ballast is available at work sites.

[3] Includes replacing buildings 100 percent, ties 30 percent, rail and turnouts 85 percent.

Maintenance Responsibilities

Once railways are constructed and turned over to TRS for operation, the TRS assumes responsibility for all minor railway maintenance in the communications and combat zones to the forward limit of traffic. See TM 55-204 for more information. TRS responsibilities include–

- Maintaining the railway communications circuits used for railway operation and administration. (Responsibility becomes effective when all circuits on the line have been turned over to the TRS.)
- Operating railway block signals of the interlocking plants and centralized traffic control devices.
- Providing unit and intermediate maintenance of signals and control devices.
- Installing, maintaining, and operating internal communications.

The TRS is normally divided into a number of divisions for maintenance and operation. Each division is assigned a railway battalion. Each battalion includes personnel from the railway engineering company who perform necessary maintenance of tracks and structures.

The battalion commander has overall responsibility for railway maintenance, including maintenance procedures, instructions, and work. The railway engineering company commander is the maintenance of way superintendent. As such, his responsibilities include inspecting and maintaining tracks and structures and supervising all maintenance work procedures. Platoon and section leaders supervise assigned maintenance operations.

Maintenance Categories

Army maintenance is divided into two categories – unit and intermediate. These categories are discussed here as they apply to locomotives and rolling stock.

Locomotives. Suitable inspection pits and facilities must be provided for inspection, repair, and adjustment of locomotive parts. Locomotives must be inspected periodically and maintenance documented according to rail technical manuals. See technical publications on equipment being maintained.

Maintenance on locomotives is normally performed in an enginehouse. Division locomotives are kept in good operating condition and at maximum availability. See FM 55-20 (for diesel-electric locomotives) for a general reference covering maintenance procedures at enginehouses.

Unit maintenance. Unit maintenance of locomotives consists of during-operation maintenance, inspection of visible moving-parts, and lubrication and repair or replacement of parts. The train operating company performs maintenance. The engineman is responsible for the equipment he operates. The balance of unit maintenance is the responsibility of the railway equipment maintenance company.

Intermediate maintenance. The railway equipment maintenance company performs intermediate maintenance. If repairs are not too extensive, they are made and the locomotive put back into service. If repairs are beyond railway workshop capability, the unit makes only those repairs needed to move the locomotive to a fixed installation for repair.

Depot maintenance. Depot maintenance is not performed by the TRS. It is beyond the capability of the transportation railway equipment maintenance company and requires evacuation to CONUS or to an appropriate base or facility.

Rolling stock. Repair track installation (rip tracks) is normally set up at main terminals. Rip tracks are also located at other points of the division, such as junction points or heavy loading centers. At these points, they make repairs that cannot be made at the loading installation, avoiding moving the cars into the main terminal. The master mechanic (railway equipment maintenance company commander) is responsible for the operation of the rip tracks.

Unit maintenance. Unit maintenance includes running repairs and inspection of rolling stock. The railway battalion train maintenance sections and crews perform unit maintenance. Military or civilian car inspectors perform maintenance at the originating terminals and at inspection points en route. They also make repairs needed to ensure safe train operation.

Intermediate maintenance. Intermediate maintenance consists of running and emergency repairs that require taking the car out of service for a short time only. The railway battalion's train maintenance sections and crews and the railway car repair companies perform intermediate maintenance. Military or civilian maintenance personnel perform intermediate maintenance at a car's home terminal or a prescribed location.

Depot maintenance. Depot maintenance is not performed by TSR units.

Maintenance of Way

Certain considerations must be factored into planning and maintenance to effectively and safely operate a rail network. Roadway, track, and structure maintenance are critical elements in maintenance of way.

Roadway. Roadway maintenance keeps the part of the right-of-way on which the track is constructed in serviceable condition. This part of the right-of-way includes excavations, embankments, slopes, shoulders, ditches, and road or stream diversions. See TM 55-204 for a detailed discussion of roadway maintenance.

Track. In a theater of operations, the track must be operable at all times. The four primary considerations in track maintenance are: gauge, surface, alignment, and dress.

The continual passing of trains around a curve eventually moves the track, altering the alignment and distorting the curve (see subparagraph, "Determining Track Curvature"). TRS maintenance of way personnel should restore the track to its correct curvature if distortion exists. They must also inspect the roadbed and track frequently for damage from sabotage, direct enemy action, or weather. Failure to do so may result in serious operating delays.

Structures. In a theater of operations, structures essential to railway operations must be maintained according to prescribed maintenance standards. These structures include bridges, culverts, tunnels, and fuel and water facilities. When repairing structures, always observe minimum clearances.

Determining Track Curvature

Degrees of track curvature impact significantly on train operation and adversely affect speeds. Track curvature is measured by either the survey or string method.

Survey method. Degree of curve (D) is a measure of the sharpness of curvature and is defined as the angle subtended at the center of curvature by a chord 100 feet long. Radius of curvature (R) is the distance (in feet) from the apex of the central angle out to the curve; mathematically, R is the reciprocal of the curvature (C) of a curve. A chord is a straight line joining two points on the curve. The arc is the continuous portion of that curved line (as a part of a circle) between the same two points. The smaller the central angle (and the greater the radius), the closer the arc measurement comes to the chord measurement (100 feet).

The area of the sector of a circle is expressed in either of two ways:

$$A = \frac{R \times arc}{2} \quad \text{or} \quad A = \frac{3.1416 \times R2 \times D}{360}$$

where: A = area
R = radius of curvature in feet
D = degrees of curvature
arc = 100 ft (since arc and chord are almost the same for a 1^{o} curve.)

To solve for R:

$$R = \frac{arc \times 360}{2 \times 3.1416 \times D} = \frac{arc \times 57.3}{D}$$

R then equals 5,730 for a 1^{o} curve and $\frac{5,730}{D}$ for a D^{o} curve.

Table 4-8, page 4-16, shows the relationship between degree of curve and radius of curvature for simple curves.

String method. If a surveying instrument is not available, compute the degree of simple curvature (arc of a circle) of a track by the string method. Although this method is not exact, the degree of error is slight. A length of ordinary field commo wire makes an ideal string. Commo wire is readily available, will not stretch, and can be rolled up and carried in the pocket. Take the following steps to determine the degree of track curvature by the string method:

- Select a portion of track well within the main body of the curve.
- Mark a 62-foot section on a length of wire or strong cord with dabs of white paint at the beginning (A), middle (M), and end (B) of the section.
- Secure A to inside of high rail (5/8 inch from top). Tightly stretch wire until B touches inside of rail (Figure 4-3, page 4-16).
- Measure the distance R from M to inside of rail. Distance in inches equals approximate degree of curve. If the distance R from M to rail measures 5 inches, then the degree of curve is 5. As a curve gets sharper, the distance R increases.

Supply Procedures

Railway supplies are expendable supplies required for the operation and maintenance of railway divisions. At the beginning of operations, all operating units must submit reports of supplies on hand. Railway supplies are distinguished from organizational supplies. Whenever possible, use local supply sources to reduce transportation requirements. In a theater of operations, sources of railway supplies include–

- Military stocks.
- Manufacturers in or near the theater.
- Foreign railways.
- Captured enemy material and equipment.
- Parts and assemblies manufactured or repaired by other railway units.
- Transfers from other railway operation units.

The battalion supply officer serves as fuel agent for the railway transportation battalion. Fuel agents must ensure that the operating TRS agencies receive enough locomotive fuel, regardless of the source. Fuel and lubricants are requisitioned through normal supply channels.

The supply officer of the highest transportation railway echelon prepares tables of allowances and supplies for all units within the command. To ensure uninterrupted operations, the supply officer determines a workable stock level allowance for each unit.

Stock levels for the railway division are usually determined from past requirements. To estimate repair parts requirements, use the factor 1.5 STONs per month for each train moving in each direction per day. Beginning with the first railway division, select the train density established for the division and multiply by 2 (for two-way travel). Then multiply the result by 1.5 for the total amount in STONs of spare parts required per month for this division. Use this process for each successive division to determine the total STONs required per month for the entire railway system. This total is an estimate only and should be revised to fit operating conditions.

Table 4-8. Degree of curve and radius of curvature for simple curves

D	R	D	R	D	R
1	5,730	7	819	13	441
2	2,865	8	716	14	409
3	1,910	9	637	15	382
4	1,433	10	573	16	358
5	1,146	11	521	17	337
6	955	12	478	18	318

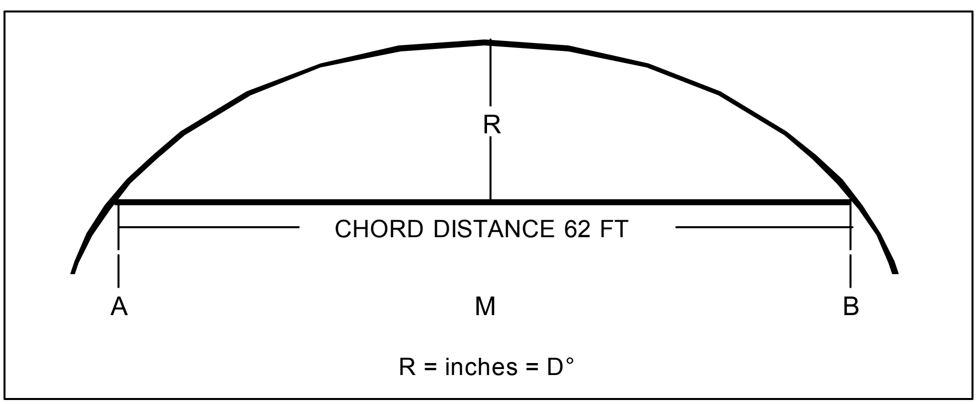


Figure 4-3. Determining curvature (string method)

Section II
RAIL TRANSPORT DATA

LOCOMOTIVE CLASSIFICATION

Different classification systems exist for locomotives in CONUS and most other countries throughout the world. Understanding the systems described in this section is essential in planning rail operations.

Whyte System

This system classifies locomotives by wheel arrangement. The Army uses the Whyte System. Although originally developed for steam locomotives, this system may be used for any type of motive power. Three or more digits separated by a hyphen designate the number of wheels on the locomotive. The first digit represents the number of leading or "guide" wheels, the second the number of drive wheels, and the third the number of trailing wheels. If there are no trailing wheels, then the figure "0" is used in each case. Two separate sets of driving wheels are shown as two separate digits – always with a hyphen between them. For example:

- 2-8-2. Denotes a locomotive with one pair of leading wheels, four pairs of coupled driving wheels, and one pair of trailing wheels.
- 2-8-0. Denotes a locomotive with one pair of leading wheels, four pairs of coupled driving wheels, and no trailing wheels.
- 0-6-6-0. Denotes a locomotive with no leading or trailing wheels and two sets of three driving wheels each.

Continental System

The classification system commonly used in Europe and other parts of the world classifies locomotives by axles rather than wheels. Powered axles are represented by letters – "A" being one powered axle, "B" two powered axles, "C" three, and so on. Nonpowered or idling axles are represented by numerals. Using this system, the Army 0-4-4-0 would be a "B-B" and the 0-6-6-0 would be a "C-C." A 2-8-0 steam locomotive would be a 1-D-0. A locomotive with two six-wheeled trucks would not necessarily be equipped with all axles powered, usually the middle axle being an idler. This locomotive would then be shown as an "A-1-A+A-1-A," the plus sign (+) representing the separation of the front and rear trucks.

RAILWAY EQUIPMENT CHARACTERISTICS

The Official Railway Equipment Register provides data on DOD cars under MTMC control. This publication also contains data on all US rolling stock and is updated quarterly. The ITO at each CONUS installation should have the most current edition on hand. See Tables 4-9 through 4-19, pages 4-18 through 4-26, for railway equipment characteristics as follows:

- Motive power.
  - Locomotives – Table 4-9, page 4-18.
  - Locomotive cranes – Table 4-10, page 4-20.
  - Railway maintenance motor cars – Table 4-11, page 4-21.
- US rolling stock.
  - Open-top cars (gondolas and hopper cars) – Table 4-12, page 4-21.
  - Flatcars – Table 4-13, page 4-22.
  - Boxcars – Table 4-14, page 4-22.
  - Refrigerator cars – Table 4-15, page 4-22.
  - Tank cars – Table 4-16, page 4-23.
  - Special-purpose cars – Table 4-17, page 4-23.
- German rolling stock – Table 4-18, page 4-24.
- Korean rolling stock – Table 4-19, page 4-26.

Table 4-9. Characteristics of locomotives

TYPE	GAUGE (in)	WEIGHT (lb)	LENGTH OVER COUPLERS	EXTREME WIDTH	EXTREME HEIGHT	TRACTIVE FORCE (LB) Starting at 30% Adhesion	TRACTIVE FORCE (LB) Continuous	HORSE-POWER	CURVATURE MINIMUM RADIUS (ft)	FUEL CAPACITY (gal)
Diesel-Electric:										
131-T, 0-6-6-0, domestic and foreign svc	56 1/2	262,900	55’	10’ 0”	14’ 0”	75,700	37,850 at 10 MPH	1,000	231	1,600
127-T, 0-6-6-0, domestic and foreign svc	56 1/2	261,100	55’	10’ 0”	14’ 0”	75,700	37,850 at 10 MPH	1,000	231	1,600
120-T, 0-6-6-0, domestic and foreign svc	56 1/2, 60, 63, 66	240,000 245,000 w/steam generator	57’ 5”	9’ 8”	13’ 6”	73,000	37,000 at 10 MPH	1,600	193	1,600 800 w/steam generator
120-T, 0-6-6-0, domestic and foreign svc	56 1/2, 60, 63, 66	240,000 245,000 w/steam generator	56’ 9”	9’ 7”	13’ 5”	72,000	36,000 at 10 MPH	1,600	193	1,600 800 w/steam generator
120-T, 0-4-4-0, domestic svc	56 1/2	240,000	55’ 9”	10’ 3”	14’ 6”	75,000	40,000 at 11 MPH	1,500	150	800
120-T, 0-4-4-0, domestic svc	56 1/2	246,000	48’ 10”	10’ 2”	14’ 6”	73,000	36,000 at 10 MPH	1,200	100	750
115-T, 0-4-4-0, domestic svc	56 1/2	230,000	45’ 6”	10’ 0”	14’ 6”	69,000	34,000 at 15 MPH	1,000	50	635
100-T, 0-4-4-0, domestic svc	56 1/2	199,000	44’ 6”	10’ 0”	14’ 4”	59,700	28,750 at 10 MPH	660	50	635
100-T, 0-4-4-0, domestic svc	56 1/2	200,000	44’ 5”	10’ 0”	14’ 7”	69,700	35,000 at 10 MPH	800	100	600
80-T, 0-4-4-0, domestic svc	56 1/2	161,000	36’ 10”	9’ 6”	13’ 7”	48,000	24,000 at 10 MPH	500	75	400
80-T, 0-4-4-0, domestic svc	56 1/2	161,000	36’ 10”	9’ 6”	13’ 7”	48,000	24,000 at 10 MPH	470	75	400
80-T, 0-4-4-0, domestic svc	56 1/2	161,600	41’ 0”	9’ 6”	13’ 4”	48,000	21,000 at 5.2 MPH	550	75	400

Table 4-9. Characteristics of locomotives (continued)

TYPE	GAUGE (in)	WEIGHT (lb)	LENGTH OVER COUPLERS	EXTREME WIDTH	EXTREME HEIGHT	TRACTIVE FORCE (LB) Starting at 30% Adhesion	TRACTIVE FORCE (LB) Continuous	HORSE-POWER	CURVATURE MINIMUM RADIUS (ft)	FUEL CAPACITY (gal)
Diesel-Electric (continued):										
65-T, 0-4-4-0, domestic svc	56 1/2	130,000	34' 0"	10' 11"	13' 5"	39,000	19,500 at 10 MPH	400	75	250
60-T, 0-4-4-0, domestic and foreign svc	56 1/2, 60, 63, 66	122,000	38' 11" (Type E) 39' 3" (Willison)	9' 6"	13' 4"	26,000	15,680 at 7.78 MPH	500	75	500
45-T, 0-4-4-0, domestic and foreign svc	56 1/2	90,000	33' 6"	9' 7"	12' 0"	27,000	12,000 at 6 MPH	380	75	250
45-T, 0-4-4-0, domestic svc (side rod drive)	56 1/2	90,000	28' 4"	9' 6"	12' 0"	27,000	13,500 at 6.2 MPH	300	50	165
44-T, 0-4-4-0, domestic svc	56 1/2	91,270	33' 10"	9' 4"	13' 3"	26,400	11,000 at 9 MPH	380	75	250
44-T, 0-4-4-0, domestic svc	56 1/2	99,000	33' 5"	10' 1"	13' 3"	26,400	13,000 at 7.1 MPH	380	50	250
25-T, 0-4-0, domestic svc	56 1/2	50,000	16' 1"	8' 7"	10' 4"	15,000	6,200 at 6.2 MPH	150	50	75
Gasoline/Diesel-Mechanical:										
10-T, single-engine, 0-4-0, domestic svc	56 1/2	20,000	—	—	—	—	—	100	75	30 (diesel)

Table 4-10. Characteristics of locomotives cranes

TYPE	GAUGE (in)	WEIGHT (lb)	LENGTH OVER COUPLERS	EXTREME WIDTH	EXTREME HEIGHT	BOOM LENGTH (ft)	REACH RADIUS AND CAPACITY	
							Main Hoist	Aux Hoist
Locomotive, steam, wrecking, 75-T, broad gauge, domestic and foreign svc	56 1/2, 60, 63, 66	191,000	30’ 10”	17’ 10”	10’ 4”	25 (2-piece, curved)	16’ (75-T) 25’ (34-T)	25’ (10-T) 30’ (8-T)
Locomotive, crane, diesel, mech, 150-T, domestic svc	56 1/2	291,700	31’ 0”	15’ 6”	10’ 4”	28 (2-piece, straight)	28’ (67-T)	—
Locomotive, diesel, elec, 40-T, broad gauge, domestic and foreign svc	56 1/2, 60, 63, 66	221,500	36’ 1”	13’ 6”	10’ 4”	50 (2-piece, straight)	12’ (40-T) 50’ (6 3/4-T)	— —
Locomotive, diesel, elec, 40-T, domestic svc	56 1/2	220,000	29’ 4”	15’ 1”	10’ 6”	50 (2-piece, straight)	12’ (40-T) 50’ (6 3/4-T)	— —
Locomotive, diesel, mech, 25-T, broad gauge, domestic and foreign svc	56 1/2, 60, 63, 66	148,000	27’ 7”	13’ 0”	8’ 6”	50 (2-piece, straight)	12’ (25-D 50’ (4-T)	— —
Locomotive, diesel, mech, 25-T, narrow gauge, foreign svc	36, 39 3/8, 42	152,000	32’ 6”	12’ 0”	8’ 6”	40 (2-piece, straight)	12’ (25-T) 40’ (6-T)	— —
Locomotive, diesel, mech, 25-T, domestic svc	56 1/2	155,000	30’ 0”	15’ 2”	10’ 8”	50 (2-piece, straight)	12’ (25-T) 50’ (4-T)	— —
Locomotive, diesel, mech, 35-T, domestic svc	56 1/2	167,000	30’ 0”	15’ 7”	10’ 4”	50 (2-piece, straight)	12’ (35-T) 50’ (5-T)	— —

Table 4-11. Characteristics of railway maintenance motor cars

TYPE	GAUGE (in)	WEIGHT (lb)	LENGTH (in)	WIDTH (in)	HEIGHT (in)	CAPACITY	HORSE-POWER	FUEL CAPACITY (gal)
Gasoline, mech, 4 wheels, solid drawbar couplers, closed cab with cabhand brake	56 1/2	2,950	112	65	58 w/o cap	8 person	62.6	8
Gasoline, mech, 4 wheels, solid drawbar couplers, open body with hand brake	56 1/2	1,700	103	65	50	10 person	62.6	8

Table 4-12. Characteristics of open-top cars

TYPE	GAUGE (in)	NORMAL CAPACITY		INSIDE DIIMENSIONS			LIGHT WEIGHT (STON s)
		(lb)	(cu ft)	Length	Width	Height	
Gondolas:							
High side, 8W, narrow gauge, foreign svc	36, 39 3/8, 42	60,000	940	34’ 5”	6’ 10 1/2”	4’	13.0
Low side, 8W, narrow gauge, foreign svc	36, 39 3/8, 42	60,000	356	34’ 6”	6’ 10 1/2”	1’ 6”	12.1
High side, 8W, broad gauge, foreign svc	56 1/2	80,000	1,680	40’	8’ 3 3/4”	4’	18.0
Low side, 8W, broad gauge, foreign svc	56 1/2, 60, 63, 66	80,000	500	40’ 4 1/2”	8’ 3 1/4”	1’ 6”	16.0
Low side, 8W, drop ends, domestic svc	56 1/2	100,000	1,184	41’ 6”	9’ 6 1/8”	3’	23.0
High side, std gauge, domestic svc	56 1/2	100,000	1,580	41’ 6”	9’ 6”	4’ 6”	25.0
Hopper Cars:							
8W, domestic svc	56 1/2	100,000	—	33’	9’ 5 1/2”	9’ 7”	—

Table 4-13. Characteristics of flatcars

TYPE	GAUGE (in)	NORMAL CAPACITY (lb)	PLATFORM LENGTH	PLATFORM WIDTH	PLATFORM HEIGHT ABOVE RAIL	LIGHT WEIGHT (STON s)
8W, narrow gauge, foreign svc	36, 39 3/8, 42	60,000	34' 8 1/2"	7' 2"	3' 7"	10.9
12W, domestic svc	56 1/2	200,000	54'	10' 6 1/2"	4' 1 1/4"	35.0
8W, domestic svc	56 1/2	140,000	49' 11 1/2"	10' 3 1/4"	3' 8 1/2"	27.0
12W, broad gauge, foreign svc, 80-T	56 1/2, 60, 63, 66	160,000	46' 4"	9' 8"	4' 2 7/8"	35.3
12W, domestic svc (passenger train svc)	56 1/2	200,000	54'	10' 6 1/4"	4' 5 3/8"	—
8W, domestic svc	56 1/2	100,000	43' 3"	10' 6"	3' 8"	25.5
8W, broad gauge, foreign svc	56 1/2, 60, 63, 66	80,000	40' 9"	8' 7 1/4"	3' 6 15/16"	14.5
8W, broad gauge, depressed center, foreign svc	56 1/2, 60, 63, 66	140,000	50' 7"	9' 8"	NA	41.5

Table 4-14. Characteristics of boxcars

TYPE	GAUGE (in)	CAPACITY (lb)	CAPACITY (cu ft)	INSIDE DIMENSIONS Lenth	INSIDE DIMENSIONS Width	INSIDE DIMENSIONS Height	DOOR DIMENSIONS	LIGHT WEIGHT (STON s)
8W, domestic svc	56 1/2	100,000	3,975	50' 6"	9' 3"	10' 6"	10' wide, clear opening .8' high, clear opening	23.0
8W, broad gauge, foreign svc	56 1/2, 60, 63, 66	80,000	2,520	40' 6"	8' 6"	6' 5 5/8"	6' 8 3/4" wide 8' 3 1/4" high	18.5

Table 4-15. Characteristics of refrigerator cars

TYPE	GAUGE (in)	NORMAL CAPACITY (lb)	LENGTH INSIDE SIDE LINING	WIDTH INSIDE SIDE LINING	ICE CAPACITY (lb)	DOOR DIMENSIONS
8W, disassembled, foreign svc	56 1/2	80,000	38' 9 1/2"	6' 11"	11,000	4' wide 7' high
8W, disassembled, broad gauge, foreign svc	56 1/2, 60, 63, 66	80,000	32' 1/2"	7' 8" (approx)	11,000	4' wide 7' high
8W, mechanical, foreign svc	56 1/2, 60, 63, 66	80,000	40' 9" equipment compartment	7' 6" (approx)	None	6' wide 7' high

Table 4-16. Characteristics of tank cars*

TYPE	WHEEL GAUGE	CAPACITY (gal)	MAXIMUM CAPACITY (lbs)	LIGHT WEIGHT (STON s)	PRESSURE
DOT-103W General Purpose	56 1/2	Various	110,000	30	<101 psi
DOT-103AW Nickel-clad	56 1/2	Various	119,000	30	<101 psi
DOT-105S500W Insulated (Compressed Gases)	56 1/2	Various	135,000	40	500 psi
DOT-111A100W1 Insulated	56 1/2	Various	200,000	35	100 psi
DOT-111A100W1 Insulated (Caustic Soda Service)	56 1/2	15,000+	200,000	33	100 psi
DOT-111A60ALW2 (Nitric Acid Service)	56 1/2	15,000+	200,000	25	60 psi

*See UTLX or GATX Tank Car Manuals for detailed tank car specifications.

Table 4-17. Characteristics of special-purpose cars

TYPE	GAUGE (in)	WEIGHT (LB)		OVER END SILLS		HEIGHT ABOVE RAIL	REMARKS
		Light	Loaded	Length	Width		
Car, amb unit, 8W, domestic svc	56 1/2	157,000	167,300	78’ 11”	10’	13’ 6”	Capacity: 27 patients, 6 corpsmen, 1 nurse, 1 doctor
Car, guard, domestic svc	56 1/2	92,740	99,300	57’	9’ 1”	14’ 2 1/2”	Air-conditioned, shower, toilet, kitchen, 2 sleeping compartments
Car, kitchen, troop/ amb train, 8W, domestic svc	56 1/2	100, 160	NA	54’ 2 1/2”	9’ 5 3/4”	13’ 6”	Width, side door opening: 6’
Car, kitchen, dining and storage, amb train, 8W, foreign svc	56 1/2, 60, 63, 66	111,400 (avg)	NA	63’ 1/4”	9’	13’	Seat capacity: 24
Car, personnel, amb train	56 1/2, 60, 63, 66	111,400 (avg)	NA	63’ 1/4”	9’	13’	Berth capacity: 15 EM, 4 doctors, 2 nurses

Table 4-18. Characteristics of German freight cars

TYPE	NUMBER OF AXLES	LIGHT WEIGHT (STONs)	CAPACITY WEIGHT (STONs)	CUBE (cu ft)	INSIDE DIMENSIONS			DOOR DIMENSIONS		HEIGHT OF FLOOR ABOVE TOP RAIL
					Length	Width	Height	Width	Height	
Boxcar, G	2	11.4	16.5	1,500	25’ 11 3/4”	8’	7’ 4 9/16”	4’ 11 1/16”	6’ 6 11/16”	4’ 1/16”
Boxcar, GLMHS-50	2	13.4	23.1	2,500	36’ 9 5/16”	8’ 11 1/16”	9’ 5/8”	6’ 6 1/16”	6’ 6 11/16”	4’ 9/16”
Boxcar, GM-30	2	12.7	23.1	1,700	24’ 10”	8’ 10”	31’ 4”	5’ 6’	6’	not avail
Boxcar, GMS-54	2	12.6	23.1	2,100	30’ 5 11/16”	8’ 8 11/16”	8’ 9 1/2”	5’ 10 13/16”	6’ 7 1/8”	4’ 1/16”
Boxcar, KMMKS-51	2	12.5	30.8	1,420	28’ 8 13/16”	9’ 5/8”	5’ 6 1/8”	5’ 10 13/16”	4’ 10 5/8”	4’ 1 7/16”
Boxcar, KMM8KS-58	2	14.3	29.7	1,800	28’ 8 9/16”	8’ 11 1/16”	7’ 1 5/16”	12’ 8 3/4”	6’ 6 11/16”	4’ 11/16”
Gondola, X-05 (low side)	2	not avail	23.1	320	25’ 7”	8’ 7”	1’ 4”	NA	NA	not avail
Gondola, XLM-57 (low side)	2	8.4	23.1	330	29’ 7”	8’ 6”	1’ 4”	NA	NA	4’
Gondola, OMM-37 (high side)	2	9.7	24.6	1,210	27’ 7”	9’	4’ 10”	NA	NA	4’
Gondola, OMM-52 (high side)	2	11.0	28.6	1,200	28’	8’	4’ 10”	NA	NA	4’
Gondola, OMM-55 (high side)	2	11.0	27.5	1,200	28’ 8 9/16”	9’ 3/8”	4’ 11 1/16”	5’ 10 1/2”	NA	4’ 7/8”
Gondola, OMM-53 (high side)	2	12.1	27.5	1,200	28’	8’ 9”	4’ 10”	NA	NA	4’
Gondola, OMM-33 (high side)	2	11.5	27.0	1,260	28’ 7 3/16”	9’ 7/16”	5’ 1”	4’ 11 1/16”	NA	4’ 5/8”
Flatcar, R-10[1]	2	10.6	16.5	NA	33’ 25/16”	8’ 9”	NA	NA	NA	4’
Flatcar, RM-31[1]	2	14.3	22.1	NA	34’ 11 9/16”	8’ 6 5/16”	NA	NA	NA	4’ 1 1/8”
Flatcar, RMM-33[1]	2	11.4	27.0	NA	34’ 8 3/8”	9’ 2 1/4”	NA	NA	NA	4’ 1 1/4”
Flatcar, RLMMS-56[1]	2	14.0	25.3	NA	40’	8’ 11”	NA	NA	NA	4’
Flatcar, SM-41[1]	2	11.9	23.1	NA	41’ 6”	8’ 9”	NA	NA	NA	not avail
Flatcar, SS-15[1]	4	21.5	40.2	NA	48’ 2”	8’ 9”	NA	NA	NA	not avail
Flatcar, SSLMA-44	4	22.7	44.1	NA	59’ 2 7/16”	9’ 1/4”	NA	NA	NA	4’ 5 3/4”

Table 4-18. Characteristics of German freight cars (continued)

TYPE	NUMBER OF AXLES	LIGHT WEIGHT (STONs)	CAPACITY WEIGHT (STONs)	CUBE (cu ft)	INSIDE DIMENSIONS Length	INSIDE DIMENSIONS Width	INSIDE DIMENSIONS Height	DOOR DIMENSIONS Width	DOOR DIMENSIONS Height	HEIGHT OF FLOOR ABOVE TOP RAIL
Flatcar, SSLMAS-53	4	26.3	61.6	NA	60' 8 5/16"	8'11 13/16"	NA	NA	NA	4' 6 1/8"
Flatcar, SSKM-49	4	17.1	55.1	NA	40' 8 3/4"	8' 5 15/16"	NA	NA	NA	4' 3 9/16"
Flatcar (USA-owned)	4	16.7	50.0	NA	40' 9"	8' 5 3/4"	NA	NA	NA	4' 3 9/16"
Tank car	2	14.0	NA	(2)	21' 2"	NA	not avail	NA	NA	5'
Tank car	4	26.4	NA	(3)	33' 1/2"	NA	not avail	NA	NA	5'
	(MTs)	(MTs)	(cu m)	(m)	(m)	(m)	(m)			
RS 683,684,685	4	24.0	56.0	51.3	18.5	2.77	NA	NA	NA	1.33
RS689	4	23.6	56.0	51.0	18.5	2.77	NA	NA	NA	1.33
REMMS665	4	21.4	58.5	35.1	12.6	2.78	NA	NA	NA	1.33
RES686	4	25.0	55.0	49.0	18.5	2.75	NA	NA	NA	1.23
SA705	6	22.3	67.5	35.3	11.2	2.73	NA	NA	NA	1.43
SA (h) S710	6	31.0	65.0	45.7	15.0	2.56	NA	NA	NA	1.37
SAhs 711	6	31.5	64.0	turning side jacks flooding molds	NA	2.90	NA	NA	NA	NA
SGjs 716 (w)718	4	24.0	18.8	55.0	2.7	NA	NA	NA	NA	1.24
shis	4	22.7	NA	NA	NA	NA	NA	NA	NA	NA
SAS709	6	30.6	65.0	46.0	15.0	3.09	1.37	NA	NA	NA
TS851	2	11.7	28.0	24.0	8.76	2.76	1.68	NA	NA	1.25
TCS850	2	11.6	28.0	24.0	8.66	2.76	1.68	NA	NA	1.25
TIS858	2	13.0	26.5	23.8	8.75	2.72	2.16	NA	NA	1.23
Tbis871	2	15.1	24.5	34.0	12.7	2.67	2.26	NA	NA	1.17
Tbis 869, 870, 875	2	14.4	25.5	34.0	12.7	2.67	2.26	NA	NA	1.17

[1] Height of flatcar is determined by height of stanchion.
[2] 4,356 US gallons.
[3] 14,266 US gallons.

Table 4-19. Characteristics of Korean freight cars

TYPE	NUMBER OF AXLES	LIGHT WEIGHT (STON s)	CAPACITY WEIGHT (lb)	CAPACITY CUBE (cu m)	INSIDE DIMENSIONS (M) Length	INSIDE DIMENSIONS (M) Width	INSIDE DIMENSIONS (M) Height	DOOR DIMENSIONS (M) Width	DOOR DIMENSIONS (M) Height	HEIGHT (M) OF FLOOR ABOVE TOP OF RAIL
Boxcar:										
40-T	4	21	88,160	87	12.95	2.7	2.5	1.7	2.1	1.1
50-T	4	22	110,200	95	13.04	2.8	2.6	1.8	2.1	1.6
Gondola:										
40-T	4	19	88,160	40	11.00	2.6	1.4	NA	NA	1.1
50-T	4	20	110,200	49	13.04	2.7	1.4	NA	NA	1.6
Flatcar:										
40-T	4	16	88,160	NA	12.20	2.5	NA	NA	NA	1.1
50-T	6	20	110,200	NA	15.00	2.9	NA	NA	NA	1.2
Tank car (USA-owned)	4	22	88,160	(10,000 gal)	11.09	2.9	2.7	NA	NA	1.1

CLEARANCES AND TRACK GAUGES

Overhead and side clearances must be known before a load plan can be developed. Any equipment exceeding published clearance must be approved by the shipping industry prior to loading.

Standard Clearances

Overhead clearances and platform heights are measured from top of rail; side clearances are measured from centerline of track. See Table 4-20, page 4-27, and Figure 4-4, page 4-27 for standard minimum clearances. Local conditions may call for greater clearances.

Composite Clearance Diagrams

Sample clearance diagrams (Figure 4-5, page 4-28, and Figure 4-6, page 4-29) show the distances that equipment or cargo may project to the sides at various heights above track level. The diagrams are composites of the minimum dimensions of all similar structures in the countries listed (with corresponding track gauges) in Table 4-21, page 4-30. Not all of the limiting clearances shown in the composites will exist at once on any particular rail line. A clearance diagram must be obtained or made for the rail line being operated. Do not confuse horizontal distances shown in the diagrams with track gauge.

For example: In Figure 4-5, a vertical clearance of 3 feet 8 inches corresponds to a width clearance of at least 9 feet 8 inches. A vertical clearance of 9 3/4 inches corresponds to a width clearance not less than 8 feet 1 1/2 inches. In Figure 4-6, a vertical clearance between 13 3/4 inches and 3 feet 4 inches results when the width clearance is not more than 8 feet.

BRIDGE CAPACITY

Bridges are designed to carry specific concentrated loads safely. The best formula for determining a bridge capacity is the Cooper's E-rating.

Cooper's E-rating

The weight, in thousands of pounds, that a bridge can support for each driving axle of a locomotive is referred to as the Cooper's E-rating of the bridge. Military railroad bridges are normally designed for a Cooper's E-45 rating but may be built for lighter or heavier loads. To determine the required Cooper's E-rating of a bridge for a particular locomotive, divide the locomotive's weight on drivers by its number of driving axles.

For example, for a 2-8-0 (steam) locomotive weighing 140,000 pounds on drivers to cross a bridge safely, the bridge must have a rating of E-35 or above:

$$\frac{140{,}000}{4} = 35{,}000$$

Table 4-20. Standard minimum clearances – wires, buildings, and other structures

ITEM	CLEARANCE (m)	CLEARANCE (ft in)	ITEM	CLEARANCE (m)	CLEARANCE (ft in)
Overhead clearances:			Side clearances:		
Wires:			Buildings	2.59	8' 6"
High voltage	8.53	28' 0"	Canopies:		
Other	8.23	27' 0"	Up to 15' 6"	2.59	8' 6"
Structures	6.71	22' 0"	Higher than 15' 6"	1.68	5' 6"
			Platforms:		
			3' 9"	1.88	6' 2"
			4'	1.52	5' 0"
			Refrigerator platforms:		
			3' 2"	1.88	6' 2"
			4' 7"	2.59	8' 6"
			Enginehouse entrance:		
			Overhead	5.18	17' 0"
			Side	1.98	6' 6"

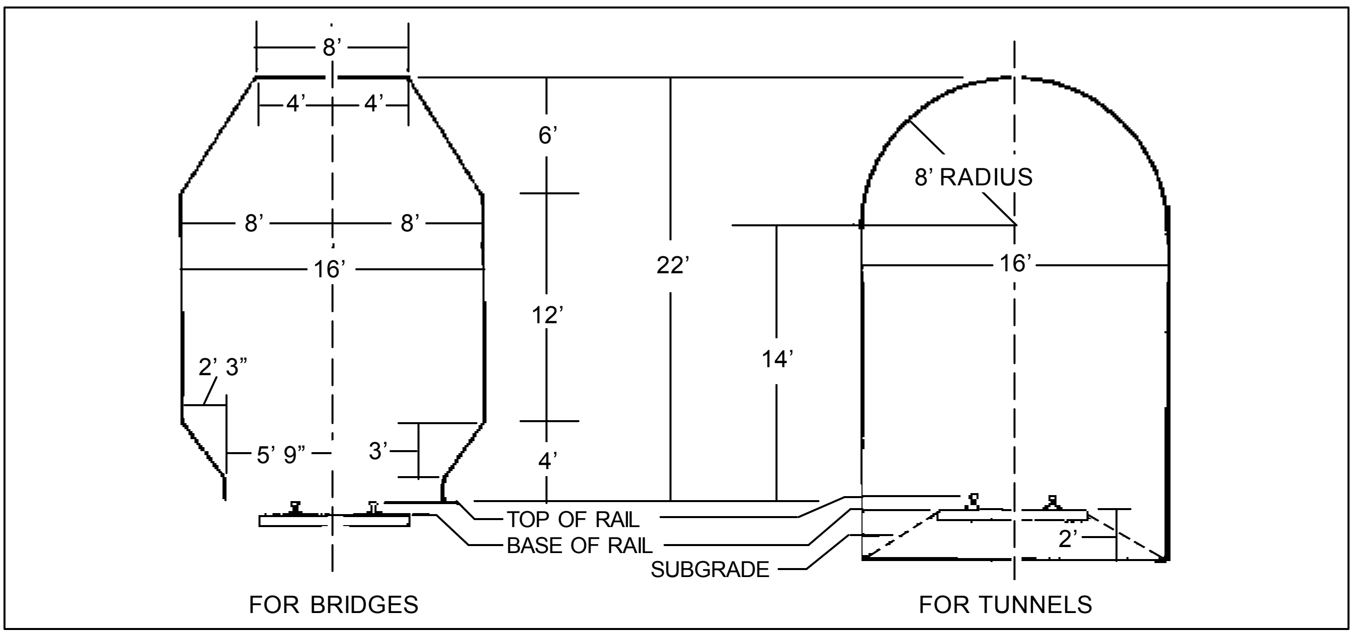


Figure 4-4. Standard minimum clearances – single-track bridges and tunnels

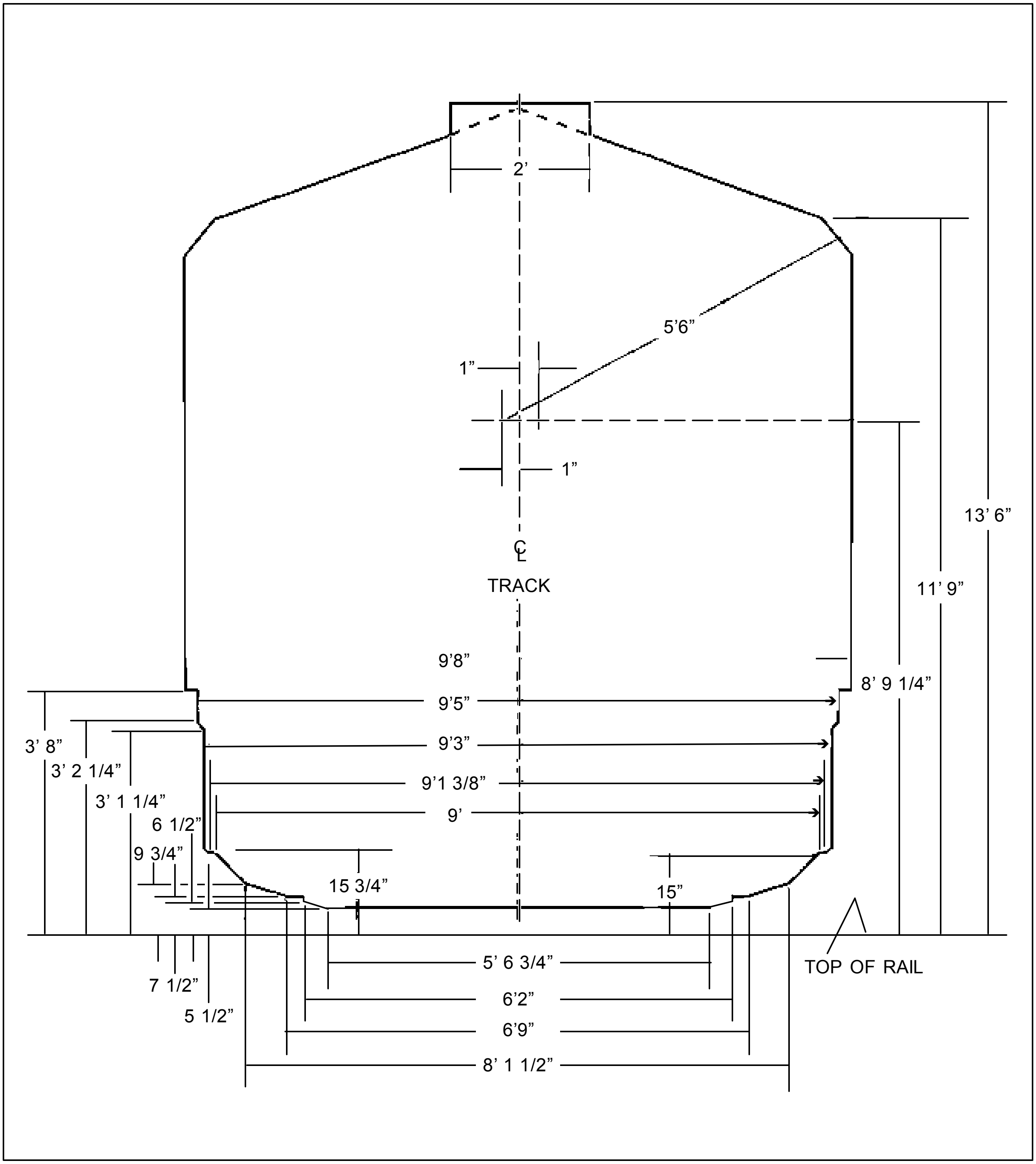
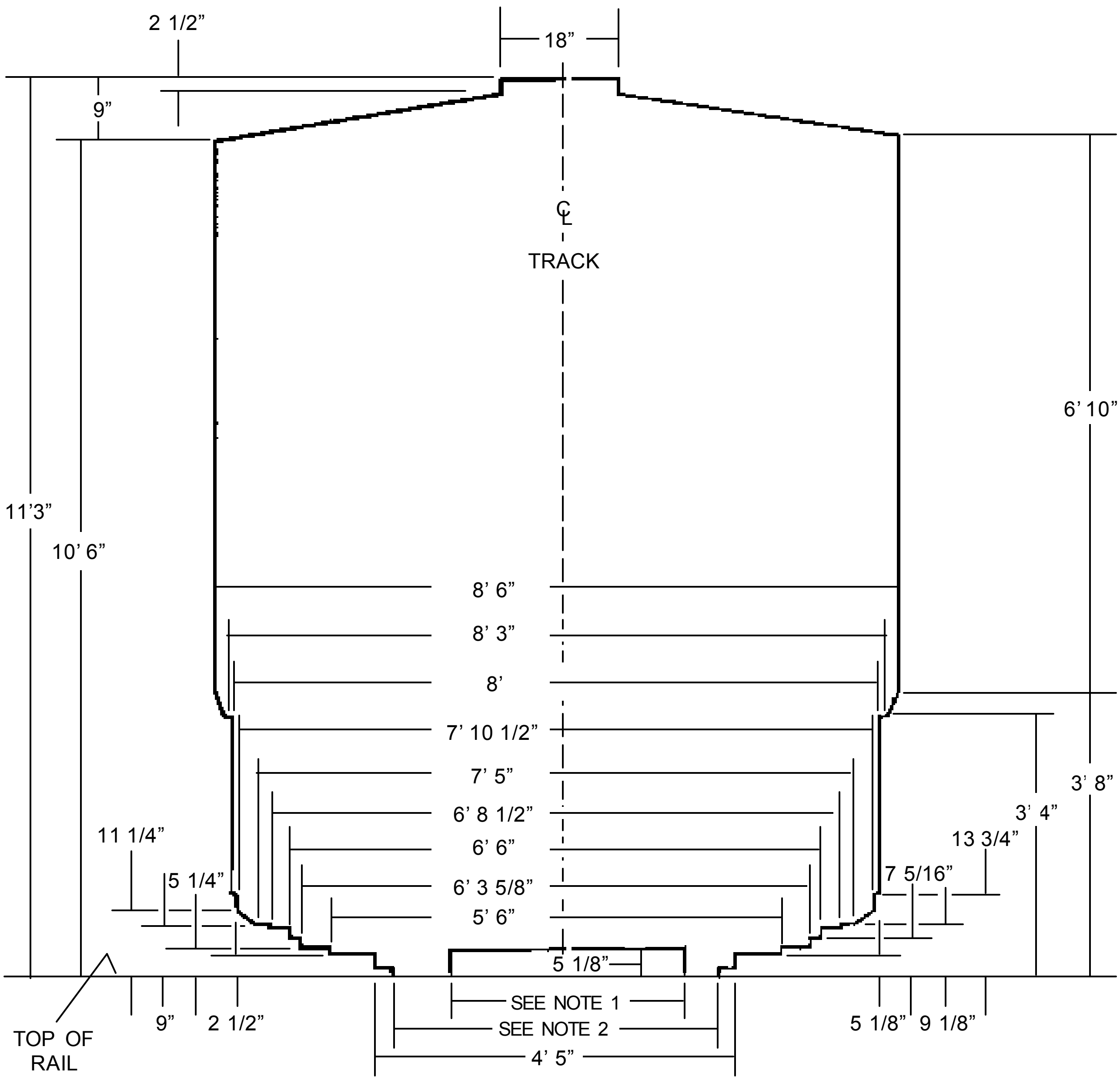


Figure 4-5. Composite clearance diagram for standard-gauge (56 1/2 in) and broad-gauge (60, 63, and 66 in) track



NOTE 1: 2’ 8 3/4” for 36-inch track gauge.
3’ for 39 3/8- and 42-inch track gauge.

NOTE 2: 4’ for 36- and 39 3/8-inch track gauge.
4’ 5” for 42-inch track gauge.

Figure 4-6. Composite clearance diagram for narrow-gauge (36, 39 3/8, and 42 in) track

Table 4-21. Track gauges of the world*

COUNTRY	GAUGES (MM)**	COUNTRY	GAUGES (MM)**
Albania	1,435	Greece	1,435; 1,000; 750; some dual gauges
Algeria	1,432; 1,055	Guatemala	914
Angola	1,067; 600	Guinea	1,000
Argentina	1,000; 1,435; 1,676	Honduras	1,067; 1,057; 914
Armenia	1,520	Hong Kong	1,435
Australia	1,435; 1067; 1,600	Hungary	1,524; 1,435; 760
Austria	1,435; 760; 1,000	India	1,676; 1,000; 762; 610
Azerbaijan	1,520	Indonesia	1,067; 750
Bangladesh	1,676; 1,000	Iran	1,435; 1,676
Belarus	1,520	Iraq	1,435
Belgium	1,435	Ireland	1,600
Benin	1,000	Israel	1,435
Bolivia	1,000	Italy	1,435; some 1,000 and 950
Bosnia-Hercegovina	1,435	Ivory Coast	1,000
Botswana	1,067	Jamaica	1,435
Brazil	1,600; 1,000; 762; 1,440	Japan	1,067; 1,435; 1,372; 762
Bulgaria	1,435; 760	Jordan	1,050
Burkina Faso	1,000	Kampuchea	1,000
Cameroon	1,000	Kazakhstan	1,520
Canada	1,435	Kenya	1,000
Chile	1,676; 1,000; 1,435	Kirgizia	1,520
China, PR	1,435; some 750	Korea, North	1,435; some narrow gauge
Columbia	914; some 1,435	Korea, South	1,435; 762
Congo	1,067	Latvia	1,520; 750
Costa Rica	1,067	Lebanon	1,435
Croatia	1,435	Liberia	1,435
Cuba	1,435	Libya	No operating railroads
Czech Republic	1,435; 750; 760	Lithuania	1,520; 1,435; 750
Denmark	1,435	Luxembourg	1,435
Dominican Republic	1,435; 762	Macedonia	1,435
Ecuador	1,067	Madagascar	1,000
Egypt	1,435	Malawi	1,067
El Salvador	914	Malaysia	1,000
Eritrea	950	Mali	1,000
Estonia	1,520	Mauritania	1,435
Ethopia	1,000	Mexico	1,435; 914
Finland	1,524	Moldova	1,520
France	1,435; 1,000	Mongolia	1,520
Gabon	1,435	Morocco	1,435
Georgia	1,520	Mozambique	1,067
Germany	1,435; some narrow gauge		
Ghana	1,067		

Table 4-21. Track gauges of the world* (continued)

COUNTRY	GAUGES (MM)**	COUNTRY	GAUGES (MM)**
Myamar (Burma)	1,000	Sudan	1,067
Namibia	1,065	Swaziland	1,067
Nepal	762	Sweden	1,435
Netherlands	1,435	Switzerland	1,435; 1,000
New Zealand	1,067	Syria	1,435
Nicaragua	1,067	Tadjikistan	1,520
Nigeria	1,067; 1,435	Taiwan	1,067
Norway	1,435	Tanzania	1,000
Pakistan	1,676; 1,000	Thailand	1,000
Panama	914; 1,524	Togo	1,000
Paraguay	1,435	Tunisia	1,435; 1,000
Peru	1,435; 914	Turkey	1,435
Philippines	1,067	Turkmenistan	1,520
Poland	1,524; 1,435; 1000; 785; 750; 600	Uganda	1,000
Portugal	1,668; 1000	Ukraine	1,520
Puerto Rico	1,000	United Kingdom	1,435; 1,600
Romania	1,435; 1,524; 760	United States	1,435
Russia	1,520; 1,067	Uruaguay	1,435
Saudi Arabia	1,435	Uzbekistan	1,520
Senegal	1,000	Venezuela	1,435
Slovakia	1,435; 1,520; 1,000; 750	Vietnam	1,435; 1,000
Slovenia	1,435	Yugoslavia (Serbia and Montenegro)	1,435
South Africa	1,065; 610	Zaire	1,067
Spain	1,668; 1,435; 1,000	Zambia	1,067
Sri Lanka	1,676; 762	Zimbabwe	1,067

* From Janes World Railways, 1995-96.
** To convert to inches, multiply milimeters by 0.04.

Steel I-Beam Bridges

Use Table 4-22, page 4-32, to determine capacity of steel I-beam bridges constructed with two, four, six, or more steel stringers or girders of equal dimensions. Assume one stringer per rail. Measure the width and thickness of the lower flange of one stringer at the center of the span length (Figure 4-7, page 4-33). Also measure the depth and length of the stringer. Then select the steel stringer that is nearest these dimensions and find the corresponding E-rating of the bridge. The age and condition of a bridge can reduce its E-rating. The quantity of this reduction must be determined by qualified personnel, normally from the Corps of Engineers. See FM 5-446 for more information concerning bridge capacities.

Wooden Bridges

Use Table 4-23, page 4-33, to determine the capacity of railway bridges with wooden stringers. Measure the width of each stringer under one track at the center of the longest span and add the measurements to obtain total stringer width. In Figure 4-8, page 4-34, the total stringer width is 2 x W. Also measure the depth and length of one stringer. Then refer to the table to find the corresponding E-rating.

MAXIMUM BULK LOADS

A car's rated load limit does not mean that it can carry the rated tonnage of all items. For many types of cargo, cubic capacity is reached before rated weight capacity. When this occurs, the tonnage of the maximum cubic capacity of the car represents its actual capacity.

Freight cars loaded with high-density items can nearly always be loaded to their rated capacity. Examples of high-density items are ammunition, barbed wire, cement, flour, gravel, corrugated iron, rails, rifles in chests, sand, stone, and engineer tools. See Table 4-24, page 4-34, for rated and actual capacities for some lighter bulk items.

Table 4-22. Capacity (E-ratings) – steel I-beam bridges

STRINGER DIMENSIONS (in)			BRIDGE CAPACITY (E-RATING) SPAN LENGTH (ft)												
Thick-ness	Width	Depth	10	11	12	13	14	15	16	17	18	19	20	22	24
3/8	8 3/8	18	E-42	E-41	E-41	E-41									
3/8	10 3/8	24		E-59	E-48	E-40	E-35	E-31	E-27						
1/2	10 3/8	30				E-61	E-59	E-51	E-46	E-41	E-37	E-33	E-30	E-27	
1/2	12 1/2	30						E-62	E-56	E-50	E-45	E-41	E-37	E-31	E-26

Thick-ness	Width	Depth	17	18	19	20	22	24	26	28	30	35	40	44	50	54	60	64
1	14	36	E-60	E-58	E-55	E-54	E-51	E-48	E-43	E-39	E-34	E-26						
1/2	12 3/8	42			E-60	E-54	E-45	E-39	E-34	E-30	E-26							
1 1/8	14	42				E-63	E-60	E-57	E-54	E-51	E-45							
1 1/8	16	42								E-60	E-54	E-42	E-32					
1 1/2	16	48									E-59	E-52	E-47	E-43	E-33			
1	16	48								E-66	E-57	E-45	E-35	E-30				
1 5/8	14	54										E-54	E-43	E-36	E-28			
1 3/4	14	60											E-60	E-54	E-43	E-37	E-30	E-27
1 1/2	14	60											E-57	E-48	E-38	E-33	E-27	

Thick-ness	Width	Depth	50	54	60	64	70	74	80	84	90
2 1/8	15	66	E-57	E-54	E-46	E-41	E-34	E-31	E-26		
2	14	66	E-56	E-48	E-40	E-35	E-30	E-26			
2	14	72	E-62	E-54	E-44	E-39	E-32	E-29	E-25		
2 1/2	15 1/2	72			E-55	E-51	E-43	E-38	E-33	E-29	
2 1/8	14	78		E-64	E-52	E-46	E-39	E-35	E-30		
2 1/2	16	84				E-64	E-54	E-49	E-41	E-38	E-30
2 11/16	20	96								E-59	E-51

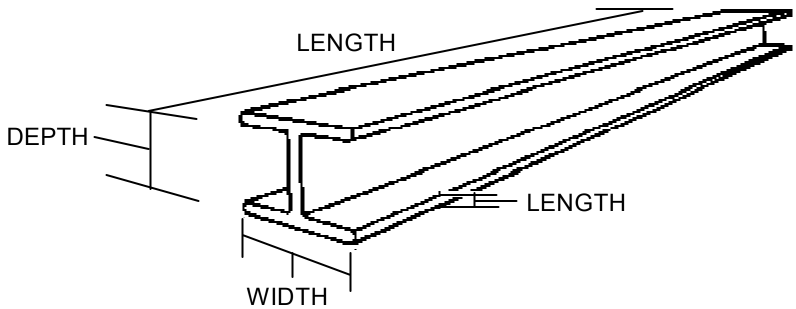


Figure 4-7. Dimensions of a steel stringer

Table 4-23. Capacity (E-ratings) – wooden bridges

STRINGER DIMENSIONS (in)		BRIDGE CAPACITY (E-RATING) SPAN LENGTH (ft)						
Width	Depth	10	12	14	16	18	20	22
18	12	E-16	E-12					
18	14	E-22	E-18	E-10				
18	16	E-28	E-20	E-15	E-10			
18	18	E-38	E-26	E-18	E-14	E-12		
20	12	E-18	E-12					
20	14	E-25	E-17	E-12				
20	16	E-33	E-23	E-16	E-12	E-10		
20	18	E-43	E-29	E-21	E-16	E-13	E-10	
24	12	E-22	E-15	E-11				
24	14	E-30	E-21	E-14	E-11			
24	16	E-40	E-28	E-20	E-15	E-12		
24	18	E-52	E-36	E-25	E-19	E-15	E-12	E-10
36	12	E-34	E-23	E-17	E-12	E-10		
36	14	E-47	E-32	E-23	E-17	E-14	E-11	
36	16	E-62	E-43	E-30	E-23	E-19	E-15	
36	18	E-78	E-53	E-30	E-30	E-24	E-20	E-16
40	12	E-38	E-26	E-19	E-14	E-11		
40	14	E-52	E-36	E-26	E-20	E-16	E-12	
40	16	E-69	E-47	E-35	E-26	E-21	E-17	E-17
40	18	E-87	E-60	E-44	E-34	E-27	E-22	E-18
48	12	E-46	E-31	E-23	E-17	E-13		
48	14	E-63	E-43	E-31	E-24	E-19	E-15	
48	16	E-69	E-47	E-35	E-26	E-21	E-17	E-17
48	18	E-105	E-73	E-53	E-41	E-33	E-27	E-22
54	12	E-52	E-35	E-27	E-19	E-15		
54	14	E-72	E-49	E-35	E-22	E-18		
54	16	E-94	E-65	E-46	E-36	E-29	E-24	
54	18	E-119	E-42	E-60	E-46	E-38	E-30	E-25
60	12	E-58	E-40	E-30	E-22	E-17		
60	14	E-79	E-55	E-39	E-30	E-35	E-20	
60	16	E-104	E-72	E-52	E-40	E-33	E-27	
60	18	E-132	E-92	E-67	E-52	E-42	E-34	E-28

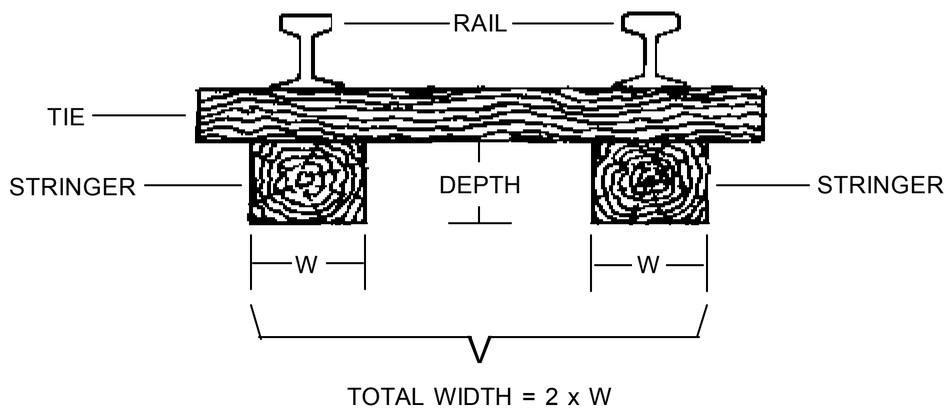


Figure 4-8. Dimensions of a wood stringer

Table 4-24. Car capacity for some low-density items

ITEM	CAR CAPACITY (STON s) RATED 30	40	50
	Actual		
Blankets, baled	27	32	40
Bread	19	24	30
Canned goods, boxed	30	36	45
Clothing, baled	27	32	40
Meat	15	24	35
Motor vehicle parts	24	28	40
Sandbags	21	24	30
Tentage	15	20	30
Ties, railroad	19	26	32

CHAPTER 5
WATER TRANSPORT AND TERMINAL OPERATIONS

Terminal operations and water transport, which includes strategic sealift and the logistic support provided by Army watercraft, are essential to projecting and sustaining forces engaged in a range of military operations worldwide. This chapter contains detailed information on all aspects of port operations and terminal planning, strategic sealift requirements and vessel types, and Army vessels and equipment.

WATER TRANSPORT AND TERMINAL UNITS

The transportation terminal battalion is generally the senior terminal activity in the theater of operations. Battalions are normally assigned to a transportation composite group. Assigned or attached units vary from command to command depending on the mission. The composite group is a combination of units most commonly assigned to the theater. It is among the "first in and last out." The 7th Transportation Group (Composite) from Fort Eustis, VA, deployed during Operations Restore Hope (Somalia), Restore Democracy (Haiti), and Vigilant Warrior (Saudi Arabia). In accomplishing its mission, the composite group–

- Operates common user APODs/SPODs for reception, discharge, and clearance of unit equipment, sustainment supplies, and retrograde cargo.
- Provides theater local and line-haul truck transportation support.
- Establishes and operates coastal and inland waterways.
- Supervises and/or conducts rail operations and maintenance of rail lines.

See Appendix A for water transport and terminal unit TOE data.

MANAGEMENT AND OPERATION OF STRATEGIC, COMMON-USER CONTINGENCY SEAPORTS

The MTMC is generally considered DOD's expert on seaport operations and capabilities. A USTRANSCOM component command, it manages and operates 10 CONUS and 15 OCONUS common-user seaports. MTMC performs the following activities on a routine or ongoing basis:

- Opens, manages, and operates contingency ports supporting military exercises.
- Books DOD cargo with commercial carriers.
- Contracts for terminal services.
- Interfaces with HNs on port-related issues.
- Prepares ship manifests and other documents.
- Develops and operates seaport management systems.
- Conducts surveys of seaport capabilities throughout the world.

Despite this acknowledged expertise in port management, theater CINCs do not always call on MTMC to assist in planning SPOD operations. MTMC's supporting role in implementing these plans may be inconsistent or ill-defined. Lacking specific doctrine and CAAs, theater port management has been arranged on an ad hoc basis. The following deployments confirm this point:

• Desert Shield/Desert Storm (Saudi Arabia). MTMC was not responsible for managing SPODs during deployment. Gradually, MTMC was assigned theater responsibility and eventually took over port management during the redeployment and retrograde phases.

• Restore Hope (Somalia). MTMC deployed three personnel temporarily to conduct port assessments. They were not assigned a port management role.

• Rwanda Relief Effort. MTMC deployed to Mombasa, Kenya, and performed the full range of port management functions.

• Uphold Democracy (Haiti). MTMC was among early deployers but did not have full responsibility for port management.

• Vigilant Warrior (AWR3 discharge). MTMC was among the first on the ground; providing the CINCCENT with predeployment planning for port operations, contracting for facilities and commercial stevedore support, and performing the full range of port management activities.

Experience gained in these operations demonstrates the need for and value of more consistent port management doctrine and seaport organization similar to that employed at aerial ports by AMC. DOD has a substantial investment in the CONUS port infrastructure. However, there is no similar deployable management force structure and doctrine for operating overseas port facilities.

A port management organization with a family of port and cargo management systems is needed to incorporate advances in information processing and communication technologies. Reduced inventory levels and increased dependence on direct vendor support, as envisioned by the BD concept, also require such an organization. To support the ITV/TAV elements of BD, a strategic distribution system must be effectively managed. Movements must be documented at every echelon in an accurate and timely manner.

A set of responsibilities has been defined that will capitalize on MTMC's expertise and core competencies at contingency SPOEs/SPODs. It solidifies MTMC's role in all scenarios as an early deployer to any theater to provide the CINC with expert port management, transportation engineering, and transportation systems support. The result will be synchronized intertheater movement between strategic and common-user SPOEs and SPODs. In laying the groundwork for the port management concept, the following must be considered:

• Military capability is required to manage, and may be required to operate, the port(s) in the theater of operations.

• The supported CINC determines command and control relationships between units with responsibilities at theater ports.

• The specific responsibilities and command relationships normally detailed in the CAA will be followed.

• Force structure, command relationships in the operational theater, and some aspects of port management and operation functions vary from one operation to the next and will be METT-T driven based on each scenario.

• Army doctrine will designate MTMC as the port manager and the transportation group (composite) the port operator.

• Where discrepancies exist between Army doctrine and an individual CAA, METT-T and the CAA will govern.

Under the port management concept, the port manager and the port operator each have specific, clearly-defined roles and functions.

Port Manager

As port manager, MTMC supports the JTF/CTF/CINC staff. The MTMC performs the following functions:

• Participates in the CINC OPLAN development and analysis.

• Conducts assessments of contingency ports to include a transportation engineering assessment.

• Advises the CINC as to the appropriate mix of military and civilian port operating capability required for a given contingency based on METT-T.

- Establishes liaison with designated HN port authorities for acquiring water terminal facilities and related services.
- Develops statements of work and contracts for stevedoring and related terminal services where such services are commercially available.
- Operates WPS, ICODES, IBS, and other theater water terminal transportation/logistics ADP systems.
- Books intertheater and intratheater surface cargo on MSC controlled common-user ships and liner service.
- Provides common-user container management services.
- Administers MSC ocean carrier contracts and vessel charters.
- Arranges for transition of military operating capability to a commercial contract or HNS.
- Participates in planning and execution of redeployment.
- Work loads the port (i.e., provides vessel discharge priorities, ship schedules, and manifest data to the port operator based on the theater commander's intent).
- Provides intertheater documentation oversight, documentation services for MSC negotiated commercial liner contracts, and other documentation services as determined by METT-T.
- Provides communication/ADP technical support for transportation/logistic ADP systems related to theater water terminals.

Port Operator

As port operator of a contingency SPOD, the transportation group (composite) or transportation battalion (terminal) will perform various functions. These functions include the following:

- Beach and port preparation and improvement.
- Cargo discharge and upload operations.
- Harbor craft services.
- Ship-to-shore movement of cargo and lighter control.
- Heavy lift services.
- Beach and port clearance command and control.
- Cargo documentation for reception, staging, and onward movement of personnel, equipment, and supplies to provide ITV to the supported CINC.

Concept of Operations

The following actions/steps are key to properly executing the port management concept:

- During the TPFDD development/refinement phase of the planning process, MTMC will provide planners to the supported CINC to develop port management and port operations requirements.
- In crisis action scenarios, MTMC will provide planners to the supported CINC for SPOD assessment and TPFDD development.
- At the request of the supported CINC and at USTRANSCOM direction, MTMC will deploy an advance party to conduct port assessments, establish contact with local port authorities, and determine availability of HNS in terms of both labor and equipment. Based on the advance party assessment and other METT-T factors, MTMC will recommend the appropriate mix of military, HNS, and civilian port operating capability required to support the contingency.
- Prior to the arrival of the first vessel, the tailored port opening package – to include the balance of the MTMC Management Cell – will deploy to the theater to support SPOD management and operations.
- MTMC will perform the theater port manager function using management cells with elements located with the CINC/JTF/CTF staff and at each designated common-user SPOE/SPOD. These organizations will perform the functions necessary to control the strategic flow of cargo and information between SPOE and hand-off to the theater.
- MTMC's port management organizations will be provisionally staffed by preselected military and civilian personnel with the basic skills needed to perform contingency port management functions. These organizations will have a rapid transition-to-war capability since most of the assigned personnel will be performing functions similar in nature to their daily peacetime activities.

• Besides the personnel and skills needed to ensure port management success, port management organizations will have and be able to use high quality information management tools including WPS, ICODES, and IBS. The MTMC management cell will deploy with and operate the C3I port management center.

• A tailored transportation group or transportation battalion (terminal) will normally perform port operations functions requiring US military capability. In all cases, this organization should be operational in theater before the first vessel arrives. The port operator executes the reception, staging, and onward movement of equipment and supplies and ensures the expeditious, well-documented transfer of deploying unit equipment into the theater of operations as directed by the theater MCA.

• In keeping with the goal of freeing military units for other possible contingencies, the supported CINC should seek to transition from a military port operation to a commercial port operation as soon as tactical conditions permit. Possible alternate port operators include HNS, third country commercial contractors, or LOGCAP. While port operators may transition between different organizations during the contingency, MTMC will perform the port manager function throughout the predeployment/deployment/redeployment process.

• Where HNS and/or commercial contractors can support all port operations requirements, there will be no requirement to deploy military units to perform these functions. In this scenario, only the MTMC management cell will deploy to establish and administer actual operations through commercial contracts.

DEFINITIONS FOR MARINE TERMINAL PLANNING

Terminal operations have a major impact on the entire transportation system. Vessel discharge and port clearance are often influenced by the capabilities of the transportation system and the receiving activities. During the planning phase of any operation involving water transport and terminal operations, these factors must be given the utmost attention. The planner should be familiar with and understand the concepts and definitions listed in this section.

Marine Terminal Operations

Operations that involve the loading, unloading, and in-transit handling of cargo and personnel between elements of the various modes of transportation in an ocean terminal environment. The five operating functions of a marine terminal are: reception, discharge, storage, transfer, and clearance.

Fixed Port Facility

The fixed port facility accommodates cargo discharge or backload operations. Sophisticated equipment and procedures characterize this type facility. It has extensive hardstand areas, transit sheds, shore cranes, and access to well-established, well-defined railnets and roadnets. Most modern fixed ports are designed to handle a specific type of cargo or combination of cargo.

Unimproved Port Facility

The unimproved port facility is not specifically designed for cargo operations. An example is a pier facility frequented by fishing vessels. This type facility is characterized by its lack of sophisticated facilities and equipment. It may have a hardstand or hard surface alongside a shallow body of water and some type of simple shore crane used for loading and discharging fishing boats. The water depth and pier length are generally inadequate for oceangoing vessels. It has sparse roadnets. Railnets are probably nonexistent. Facilities may be adaptable for cargo operations; however, upgrades needed to support these operations would include MHE, transit sheds, a marshaling area, and communications.

Bare Beach Facility

A bare beach facility has no facilities, equipment, or infrastructure available for discharging a vessel. A LOTS operation would be conducted here. The area requires considerable engineer support to develop a facility suitable for cargo operations.

Specialized Terminals

Marine ocean terminals can be broken into categories. The type of cargo loaded or discharged determines the appropriate category. These include:

- General cargo terminal – specializes in break-bulk operations. Cargo is handled as individual pieces, making operations labor-intensive.
- Container terminal – designed for an uninterrupted, high-volume flow of containers between the vessel and land transportation. A container ship can usually be discharged within 24 to 48 hours.
- RORO facility – handles cargo on wheels. Complete discharge and backloading can be accomplished in 18 to 36 hours.
- Combination terminal – handles containers and conventional cargo in the same area.

See FM 55-60 for more information on types of terminals.

LOLO Operations

Operations that involve loading equipment onto vessels using either shore or ship cranes.

RORO Operations

Operations involving the loading or discharge of a ship by driving wheeled vehicles directly onto or off of the vessel.

Administrative Loading

Administrative loading maximizes use of troop and cargo space without regard to tactical considerations. Equipment and supplies must be unloaded and sorted before they can be employed. Administrative loading is not suitable for amphibious assault operations.

Combat Loading

Combat loading involves arranging personnel and stowing equipment and supplies in a configuration that conforms to the organization's anticipated tactical operation. Individual items must be positioned so that they can be readily unloaded at the time and in the sequence that most effectively supports the planned scheme of maneuver. The three types of combat loading are as follows:

- Combat unit loading. The loading of an assault troop organization – with its essential combat equipment and supplies – onto a single ship, in such a way that it will be available to support the tactical plan upon debarkation.
- Combat organizational loading. This system allows units and equipment to debark and assemble ashore prior to tactical employment. Its use of ship space is more economical than combat unit loading.
- Combat spread loading. The loading of troops, equipment, and supplies from a single organization onto two or more ships. This system is used to deploy organizations equipped with numerous vehicles and/or large amounts of heavy equipment. One of its key objectives is to preserve the tactical capability of the force in the event of loss or diversion of a single ship. Critical CS units such as artillery and armor are often loaded this way.

Non-Self-Sustaining Ship

A non-self-sustaining vessel is one that is incapable of off-loading without cranes from external sources.

Self-Sustaining Ship

A self-sustaining vessel is capable of off-loading with organic cranes.

Supercargo Personnel

Supercargo personnel are designated (on orders) by deploying units to supervise, guard, and maintain unit cargo loaded on deploying vessels. Specific responsibilities of supercargo personnel include–

- Controlling access to cargo.
- Documenting items that cannot be repaired en route.
- Briefing the port commander at the SPOD on vehicle conditions and any unusual circumstances concerning the cargo.

For supercargo team rules and responsibilities, see FM 55-65 and Redeployment and Port Operations, Leader's Safety Guide.

Logistics Over-the-Shore

Traditionally, LOTS has been defined as operations wherein a vessel anchored in open water was discharged into lighters, with the cargo subsequently discharged over a bare beach. The current definition of LOTS encompasses not only the capability to provide initial sustainment for early entry forces over an unimproved beach, but also the following:

- Discharge through major or minor ports inaccessible or denied to deep-draft shipping.
- Intratheater sealift of cargo and equipment.
- Support of normal fixed port operations (i.e., berthing ships, providing heavy lift floating crane service, shuttling LASHs).

The scope of a LOTS operation depends on METT-T and geographic, tactical, and time considerations. The scope extends from the acceptance of ships for off-load through the arrival of equipment and cargo at inland staging and marshaling areas. See FM 55-50 for more information.

Joint Logistics Over-the-Shore

JLOTS is a LOTS operation conducted jointly by forces of two or more service components or by a unified commander. It involves the loading and discharge of vessels using lighters through major and minor ports not accessible to deep-draft ships or across beaches where there is no direct opposition by the enemy. JLOTS will exist in all but limited support operations.

Port Support Activity

The PSA is a temporary military augmentation organization. Its staff consists of personnel with specific skills who assist the port commander in receiving, processing, and clearing cargo at both the SPOE and SPOD. Stateside installations are assigned specific ports to which they must provide PSAs and other logistic support for deploying units. At the SPOD, the support group designated to support the theater and combat units provides PSA personnel. The PSA is under the operational control of the port commander while ships are being discharged.

Sea Emergency Deployment Readiness Exercise

A SEDRE is a FORSCOM fort-to-port exercise designed to train brigades on strategic deployment with the emphasis on sealift. The units are trained and evaluated on their ability to move equipment and load it onto ships within the 96-hour ASMP guideline.

ELEMENTS OF TERMINAL PLANNING

Terminal planning elements are interrelated and interdependent. They include selecting types and numbers of vessels along with port facilities, determining terminal throughput capacity, and evaluating terminal facilities on their suitability to mission requirements.

Vessel and Port Selection

Responsibility for selecting the types and numbers of vessels used to support a theater of operations is shared by MTMC and MSC. Vessel selection is based on the anticipated availability of ocean terminals and the type and volume of cargo that will be handled. MTMC, in coordination with MSC, recommends the SPOE for all CONUS ocean terminals (commercial and military). The following factors form the basis for recommendation:

- Required delivery date of the supported/supporting commander.
- Vessel transit time.
- Estimated load time.
- Port/berth availability.

MTMC mandates the cargo arrival times at SPOEs in the port call. The SPOE is selected by the supporting commander; the SPOD, by the supported command based on the MTMC and MSC recommendation.

The Army's principal management tool for terminal operations is FM 55-60. Other sources of information used in the initial phases of port selection and water terminal planning include:

- World Port Index Pub 150, published by the DMA. The World Port Index includes location, characteristics, known facilities, and available services for over 7,200 ports, shipping facilities, and oil terminals worldwide. It lists all ports by their present and former names, sailing direction number, and port index number. It also has charts showing the sequence of ports and examples of harbor types.
- Sailing Directions Fleet Guides, also published by DMA. Of the 47 volumes of Sailing Directions, 37 are Sailing Directions En Route and 10 are Sailing Directions Planning Guides. Each Sailing Directions Planning Guide covers one of the world's great land-sea areas.
- Guide to Port Entry, published by Shipping Guides Ltd. This British publication includes location, characteristics, known facilities, and available services for every major deep draft port in the world. It is divided into sections by country and lists alphabetically all the ports within that country. Also available from this publisher are The Ships Atlas and The Shipping Worlds Map.

For information on ordering these publications, see the References section of this manual.

Terminal Capacity

Twenty-four hours is generally considered a complete, round-the-clock workday for terminal and related water transport operations. The workday consists of two l0-hour shifts with 4 hours taken up by meals, shift changes, and maintenance. For planning purposes, a transportation terminal service company is capable of discharging two ships at the same time. The time it takes to discharge a vessel depends on the commodity being discharged and the facility being used.

The terminal commander estimates what is needed (in terms of construction, equipment, and personnel) to increase the terminal capacity to handle the anticipated tonnage. The terminal's actual capability is based on its sustained ability to receive and clear the daily capacity over time. The following elements are key to planning a terminal operation:

- Existing terminal capacity – total tonnage and personnel that can be received, processed, and cleared through the terminal in a day.
- Terminal workload required to support the operation – target cargo tonnage and number of personnel per day.
- Base development requirements – construction, equipment, and personnel needed to increase terminal capacity to meet target tonnage.
- Terminal reception capacity – number and type of ships that can be moved into the terminal working area.
- Terminal discharge capacity – amount of cargo and personnel that can be discharged per day.
- Transfer capacity – amount of cargo and personnel that can be moved from the discharge point to the in-transit storage areas.
- Storage capacity – amount of cargo that the in-transit storage areas can hold, based on the average dwell time of the cargo.

See Figure 5-1, page 5-8, for a checklist to use in determining throughput capacity. For more information, see FM 55-60; MTMCTEA Report SE90-3D 50; and DIAM 57-2.

Terminal Facilities

In evaluating facilities for possible use, planners should consider the availability and suitability of harbor berths and anchorages. Other considerations include wharf capacity, lighter discharge, and storage facilities. Berths and anchorages are evaluated according to the size of the vessels they can accommodate. Port capacity estimates are based on all available berthing facilities. Estimates should include all facilities suitable for handling cargo. This section discusses the factors that materially impact berthing capacity.

Checklist items	Evaluation	Result
__ Channel depths __ Obstructions __ Enemy air activity __ Enemy surface activity __ Enemy submarine activity __ Climate and seasons __ Weather __ Minefields or contaminated areas __ Capabilities in combating obstacle	Evaluate to determine water terminal reception capacity	Water terminal throughput capacity
__ Tactical dispersion requirements __ Wharf facilities __ Beach capabilities __ Discharge rates ashore __ Discharge rates in the stream __ Anchorage area __ Extent of destruction or contamination __ Climate and seasons __ Weather and tide characteristics __ Cargo-handling equipment available __ Floating craft and equipment available __ Transit sheds and in-transit storage areas __ Availability of local harbor __ Space reserved for local economy __ Enemy activity	Evaluate to determine water terminal discharge (input) capacity	
__ Capability of rail facilities __ Capacity of highway facilities __ Capacity of inland waterway facilities __ Capacity of pipeline facilities __ Capacity of air facilities __ Enemy activity __ Capability of data processing facilities	Evaluate to determine water terminal clearance (output) capacity	

Figure 5-1. Terminal throughput capacity checklist

Layout. Facility layout incorporates a number of features that affect the suitability of a terminal. Planners should evaluate facilities with these factors in mind:

- Adequacy of approaches.
- Stacking space on the landward side.
- Raised or depressed tracks.
- Stuffing and stripping sheds.
- Truck backup for stuffing and stripping sheds.
- Open storage space.
- Transit shed space.
- Number and size of transit shed doors.

Other important considerations are curbs, fences, surfacing material, depth of water alongside at high and low water, and location of on- and off-loading ramps.

Weather. Weather has a direct bearing on berth use and capacity, especially under extreme conditions.

Alignment. Excessive angle points or curvatures along the wharf face reduce usable linear footage.

Wharf construction. Deck strengths of piers, wharves, and transit shed floors are extremely important. To determine if load capacity is adequate, look at the current use of the area. If a certain cargo is normally handled, a fair load capacity evaluation can be made. The ideal load capacity is 800 or more pounds per square foot; 500 or fewer pounds per square foot is considered marginal to unacceptable. Compare the height of the wharf or pier deck to the rise and fall of the tide. This factor is significant when considering ramp use on RORO ships.

Several factors limit the use of the stern or side ramp on RORO vessels. One is the distance between the top of the pier and the water at MLW. If the distance exceeds the angle limitations of the ramps, the side or stern opening may be below the top of the pier. On certain vessels, the ramp angles may be excessive because ramp openings are too far above the pier. Vessel draft and range of tidal change also contribute to this problem. The decision as to whether a ship can use its stern or side ramps for loading during a specific period should be made on a case-by-case basis.

Work space must be sufficient to allow the unloading and clearing of cargo without delay. Work space is determined by type of wharf, length and width of the apron, exits and decking, type of cargo handled, and anticipated tonnage.

While other considerations may cause variations in berth dimensions, the loaded draft of the ship is always the controlling factor. Besides their measured LOA, vessels need 60 to 70 feet of wharf space for their mooring lines to be properly extended. See Table 5-1, page 5-10, for berth specifications.

Lighter discharge. Wharves used by lighters should be within a reasonable distance of adequate anchorages and moorings. Lighter berths are assigned in units of 100 feet for each lighter (to the nearest 100 feet). The unit measurement must be used realistically. Disregard wharf length that exceeds 100 feet but is less than the next l00-foot unit. A 350-foot wharf accommodates three lighters at the same time. All alongside berths with depths less than 18 feet are considered lighter berths.

Temporary storage. Break-bulk cargo can be temporarily stored in open or covered areas. To determine usable square footage, allow for fire lanes as well as center, intersecting, and working aisles. To determine usable cubic footage, allow for lost height in stocking odd-shaped items and for height restrictions caused by lighting and sprinklers. The following formulas enable planning for open or closed storage:

$$\text{Usable square feet} = A \times .55$$

$$\text{Usable cubic feet} = A \times B \times .45$$

$$\text{Measurement ton capacity} = \frac{A \times B \times .45}{40}$$

where:

A = available square feet

B = height available in feet of storage areas.

Open storage. Allowing 50 percent space for surge and security, about 10,000 square feet are needed for each 1,000 MTONs of cargo (10 square feet per MTON). Average stock height is 6 feet or two pallets high.

Covered storage. Approximately 7,500 square feet are required for each 1,000 MTONs of cargo (8 square feet per MTON), allowing 50 percent space for surge and security. Average stock height is 8 feet or two pallets high. Ten percent of each day's target tonnage will require covered storage.

Long-term (open or covered) storage. In a port area where temporary storage will extend for more than five days, the following formula is used to compute the storage area required:

$$\frac{\text{MTON/mo}}{2} \times \text{sq ft/MTON} \times \frac{\text{days storage}}{30} = \frac{\text{sq ft}}{\text{space}}$$

For open storage requiring 10 square feet per MTON:

$$\frac{\text{MTON/mo}}{2} \times 10 \times \frac{\text{days}}{30} = \frac{\text{sq ft open storage}}{\text{space}}$$

For covered storage requiring 8 square feet per MTON:

$$\frac{\text{MTON/mo}}{2} \times 8 \times \frac{\text{days}}{30} = \frac{\text{sq ft covered storage}}{\text{space}}$$

Cargo clearance. Cargo clearance is the act of moving cargo from shipside or temporary storage to its first destination outside the terminal area. Prompt clearance enhances the efficiency of the total theater logistic system. Cargo dwell time affects storage area capacity and is detrimental to terminal throughput capacity.

See Figure 5-2, page 5-11, for a typical terminal facility layout. For more information on terminal facilities, see FM 55-60.

LOAD AND DISCHARGE OPERATIONS

Thorough planning is crucial to the expeditious loading and unloading of strategic sealift vessels. Experience in military operations such as Operation Desert Storm and REFORGER provides a basis for determining realistic load, discharge, and port times.

Loading Operations

The amount of cargo that can be placed in a vessel varies according to the skill and compactness with which it is stowed. Proper stowage ensures that the cargo arrives at its destination undamaged and that as much cargo as possible is loaded in the available space.

Vessel load planners at MTMC use CODES, a stand-alone minicomputer system, to produce RORO prestow plans during wartime surge situations. This system replaces the time-consuming manual process. The program builds an electronic prestow plan by interfacing a data base of RORO cargo received at the port (supplied by the TSM) with a ship characteristics file of the vessel to be loaded. The vessel load planner uses CODES to distribute cargo throughout the ship and automatically calculate critical loading information. FM 55-17 explains prestowage planning and the steps for formulating stow plans.

The amount of containerized cargo, break-bulk cargo, and rolling stock greatly influences transportation planning. During peacetime about 80 percent of DOD-sponsored cargo is containerized. Wartime movements will temporarily reverse this trend because of the vast amount of unit equipment moving into the theater. However, as the theater matures, containerization will pick up.

Also, planners should consider that packaging and loading operations need special equipment and trained personnel. Cargo handlers will be handling large amounts of ammunition and may also be required to build special slings and bridles to move heavy or outsize cargo.

Table 5-1. Berth specifications

GENERAL BERTHS

Class	Length (ft)	Water Depth (ft)[1]
A	1,000	32-36
B	850	30-34
C	700	22-30
D	550	17-22
E	400	13-17
F	100	6-13

TANKER BERTH 9

Class	Length (ft)	Water Depth (ft)[1]
T-A	1,200	50-75
T-B	800	35-50
T-C	400	20-35
T-D	250	14-20

[1] Depths are computed for MLW.

Use the following formulas to calculate diameter of anchorage berths:

Offshore anchorage (diameter)= 2 (7D + 2L)

In-the-stream anchorage (diameter) = 4D + 2L x R

Where:

D = depth of water at MLW

L = overall length of ship

R = reserve factor of 1.4

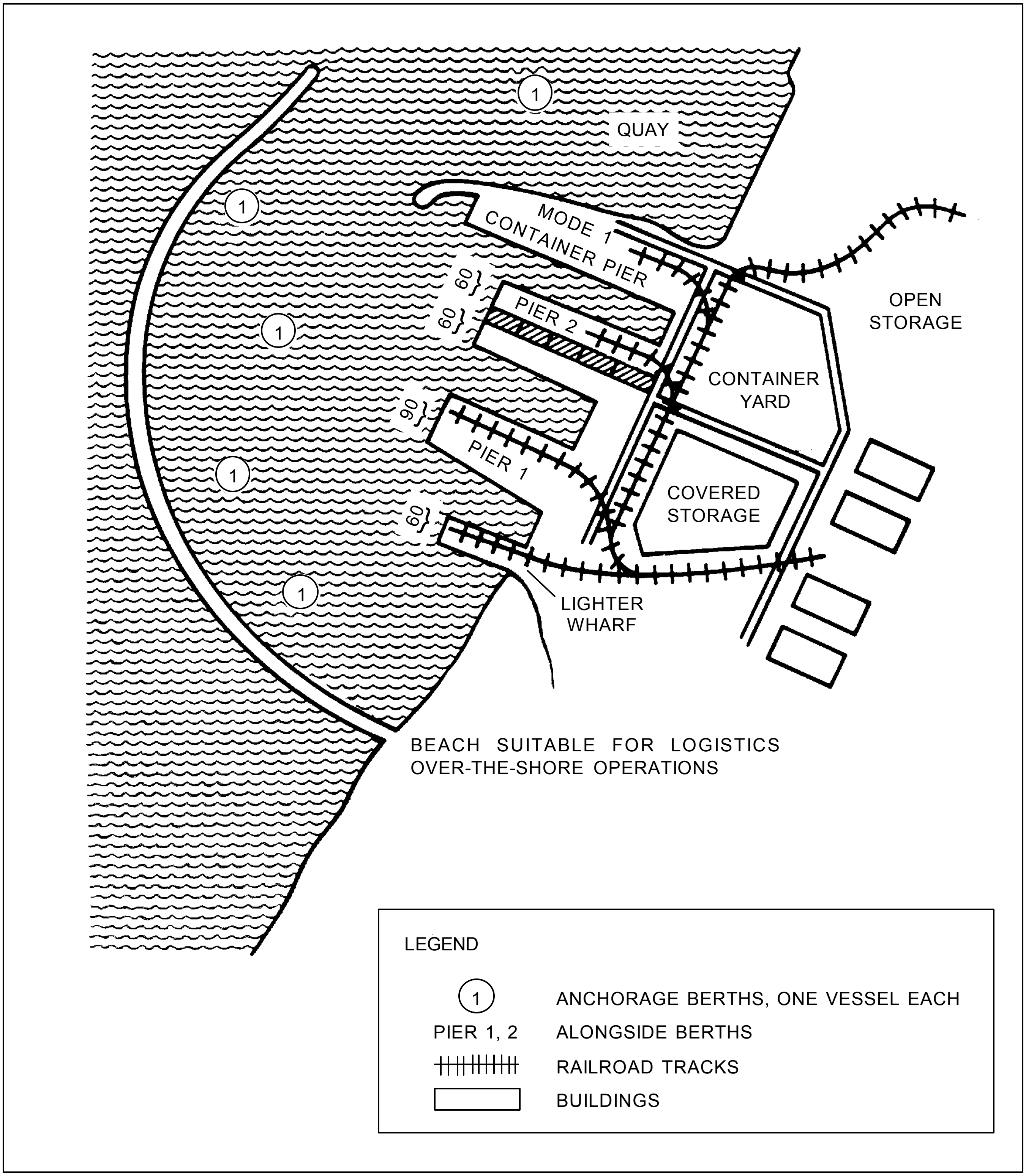


Figure 5-2. Typical terminal facility layout

Discharge Operations

The terminal battalion plans the discharge of individual ships before their arrival. Planning is based on the vessel manifests and cargo disposition instructions. Each discharge plan specifies the location within the terminal to be used, method of discharge, and units to work each vessel.

Before the discharge process begins, a ship's meeting is held aboard the vessel. The members of the boarding party may include the battalion operations officer, the company commander, the platoon leader, and an MSC representative. The boarding party coordinates the discharge plan, heavy lifts, and any other pertinent matters with the vessel master. The vessel master usually names one or two of his officers to handle operational matters. See FMs 55-17 and 55-60 for detailed coverage of ship discharge operations.

Discharge can begin with receipt of the ship's paperwork, stowage plan, ocean manifest, and cargo disposition instructions. Cargo handlers unload cargo from the vessel, segregate it, and place it aboard the mode of transportation that will either move it or put it into storage. Cargo handlers should make maximum use of berthing space.

Vessel Loading and Discharge Times

Tables 5-2 through 5-4, pages 5-12 and 5-13, list average cargo loading and discharge times for Operation Desert Storm. They are the result of an extensive analysis of Desert Storm vessel cargo operations. These tables in no way reflect the total time a ship is in port. Factors other than loading and discharge affect the total port time of a vessel. These include piloting and docking, tides and weather, bunkering, receiving ship's stores, and castoff. In planning the port time of a vessel, add one day to the vessel loading or discharge time.

Table 5-2. Desert Storm average ship loading and unloading times, deployment (unit equipment)

SHIP TYPE	AVAILABLE SQUARE FEET	PERCENT STOW	USABLE SQUARE FEET	LOAD TIME (Days)	SQUARE FEET PER HOUR	NUMBER OF PIECES	PIECES PER HOUR	UNLOAD TIME (Days)
Break-bulk	52,081	84	43,748	3	583	366	5	3
Break-bulk/ Container	71,676	71	50,890	3	719	435	6	3
FSS	200,906	73	146,661	2	2,834	850	16	3
Barge carrier- LASH	127,256	56	71,263	10	309	757	3	11
Barge carrier- SEABEE*	95,109	68	64,674	3	812	400	5	6
RORO (small)	37,265	90	33,538	1	1,761	227	12	1
RORO (medium)	75,650	83	62,789	2	1,569	392	9	2
RORO (medium/large)	124,282	73	90,726	2	2,244	539	13	2
RORO (large)	183,788	70	128,652	2	2,701	709	15	2
MPS	152,200	71	108,062	3	1,659	692	10	5
Auxiliary crane (T-ACS)	45,500	89	40,495	13	134	270	1	3

*Loading times reflect LOLO cargo operations of vehicles and combination cargoes – not barge operations.

Table 5-3. Desert Storm average ship loading and unloading times, redeployment (unit equipment)

SHIP TYPE	AVAILABLE SQUARE FEET	PERCENT STOW	USABLE SQUARE FEET	LOAD TIME (Days)	SQUARE FEET PER HOUR	NUMBER OF PIECES	PIECES PER HOUR	UNLOAD TIME (Days)
Break-bulk	59,769	64	38,252	4	404	254	3	1
Break-bulk/ Container	76,095	61	46,418	4	478	293	3	2
FSS	200,090	73	146,066	4	1,642	788	8	2
Barge carrier- LASH	177,670	30	53,301	11	200	344	1	4
Barge carrier- SEABEE [1]	95,109	76	72,283	4	865	478	6	10
RORO (small)	37,821	88	33,282	1	1,142	190	6	1
RORO (medium)	74,274	87	64,618	2	1,162	324	6	1
RORO (medium/large)	127,258	73	92,898	3	1,368	484	7	1
RORO (large)	187,408	64	119,941	3	1,720	590	9	2
MPS	152,200	82	124,804	5	1,407	1,153 [2]	9	3
Auxiliary crane (T-ACS)	45,500	95	43,225	4	456	305	3	3

[1] Loading times reflect LOLO cargo operations of vehicles and combination cargoes – not barge operations.

[2] Marine Corps equipment only.

Table 5-4. Desert Storm average ship loading and unloading times, deployment/redeployment (ammunition)

SHIP TYPE	AVAILABLE MTON	LOAD PERCENT STOW	TIME (Days)	MTON PER HOUR	UNLOAD TIME (Days)
Deployment:					
Break-bulk	9,349	70	9	30	8
Break-bulk/Container	8,800	64	9	27	8
Barge carrier-LASH	23,500	66	13	49	9
Redeployment:					
Break-bulk	9,750	83	16	38	12
Break-bulk/Container	9,000	80	21	14	9

The ship load/unload times in Table 5-5 are based on a 20-hour workday. The RORO and sea train times were computed from experience in past REFORGER exercises. This experience with MSC RORO ships is sufficient to place a high reliability on the times shown.

Loading helicopters onto RORO vessels is a LOLO operation. Since placing helicopters in their final stow position requires added effort, load and discharge times should be increased when a significant number of helicopters are transported. REFORGER experience shows that for each six helicopters, 1 hour should be added to normal load/unload times.

Documentation

During the movement process, the physical possession of cargo changes hands and possibly locations several times. Responsibility is transferred from one party to another until the consignee/unit accepts and takes receipt of the goods. The automated cargo detachment in a terminal battalion provides the documentation needed during the upload, discharge, and staging of personnel, equipment, and supplies.

Transportation Control and Movement Document. DD Form 1384 serves as a dock receipt, a cargo delivery receipt, an accountability document during temporary holding, and a record of all cargo handled. The form for each transportation unit is originated by the shipper and accompanies the cargo to the ultimate consignee. It can be prepared manually or mechanically as a punch card. DOD Publication 4500.32-R, Volume 1, and FM 55-17 contain detailed instructions for preparing and processing the TCMD.

Table 5-5. Load/unload times for basic cargo

TYPE OF SHIP	TIME IN DA YS[1] Load	Unload
RORO [2]	1.0	0.7 [5]
RORO SL-7 [2]	1.5	1.0
Seatrain	3.0	2.0
Break-bulk:		
Ammunition	4.0	4.0
Unit equipment	4.0	2.0
General cargo	4.0	4.0
Container [3]	1 or 2 [4]	1 or 2 [4]
LASH [5, 6]	1 or 2 [4]	1 or 2 [4]
SEABEE [5, 7]	1 or 2	1 or 2

[1] Assumes 20-hour workday; excludes weather and mechanical delays.

[2] Refer to following paragraph on helicopter loading.

[3] Assume availability of at least two gantry cranes per berth. Load/unload time is exclusive of container stuffing/unstuffing time.

[4] One day required for less than 900 containers, 2 days for more than 900 containers.

[5] These are general planning times; refer to following paragraphs for loading LASH and SEABEE ships.

[6] One day to load or unload ships and two days (four for ammunition) to load or unload lighters; load/unload times for lighters should be increased to three days for a unit move involving helicopters. The ship and lighter operations may run concurrently. In any event, allow a minimum of two days for load/unload operations (including lighters) involving unit equipment or resupply.

[7] One day to load or unload ship and two days to load or unload barges when barges are loaded or unloaded at SPOE. Allow a minimum of two days for concurrent operations, depending on barge berthing and terminal throughput capabilities.

Transportation Control Number. The TCN is a 17-digit number/letter code group. It consists of the unit identification code and a six-digit shipment unit number. It appears in Block 10 of the TCMD, in the LOGMARS bar code, on the first line of the address on a cargo shipping label, on the front and rear bumpers of vehicles, and on all other Army equipment (such as MHE, aircraft, floating craft, construction equipment). The TCN identifies and controls shipment throughout the transportation system. It is the single most important piece of information in the address because it is the reference point for all MILSTAMP documents, shipping actions, and tracer actions. See Figure 5-3 for the data contained in a MILSTRIP TCN.

Logistics Applications of Automated Marking and Reading Symbology. LOGMARS is an electronic computer hardware and software system used to document all types of cargo. LOGMARS bar coded labels contain the TCN and other data needed to match labels and equipment (Figure 5-4, page 5-16). Two identical bar code labels are affixed to each piece of cargo, equipment, or container. A handheld portable bar code reader scans the LOGMARS labels as cargo comes aboard the vessels or lighters. The cargo is scanned again as it is discharged.

Worldwide Port System. Currently being fielded, the WPS is a single-standard AIS. It is designed to support cargo documentation and tracking at common user ocean terminals associated with MTMC, FORSCOM ACDs, and Reserve TTUs. This system transmits and receives ocean cargo data via electronic communications, plans the receipt and load/discharge of the vessel, and supports the discharge and routing of cargo out of the POD.

The WPS will replace four cargo documentation AISs: TERMS-Import and Export, DASPS-E, MED prototype, and the TSM with a single integrated AIS. It will support worldwide peacetime and wartime operations of common water terminals and the requirements of the water terminal units designed to support the contingency mission. The WPS will operate off of a super microcomputer file server with multiple printers and work stations.

Container Operations

Containerization is the preferred method of moving military cargo. As indicated previously in this chapter, 80 percent of peacetime military cargo is transported in containers. In either peace or war, the terminal planner can anticipate handling a large number of containers.

Terminal layout. A typical container terminal consists of the ship berth, container cranes, entry facilities, marshaling area, container inspection garage, container packing shed, and equipment storage.

Containership berths require a minimum length of 1,000 feet to handle the size of vessels in use today. A maximum length of 1,100 feet will take the largest container ship currently afloat or projected. Unless local conditions dictate otherwise, container berths should be along a quay rather than a finger pier. Placing containers along a quay allows some flexibility in berth lengths.

AT4015	7250	2026	X	X	X
1	2	3	4	5	6

1. Activity address code
2. Year and Julian date of requisition
3. Requisition serial number
4. Suffix to requisition when filled by more than one supply agency
5. Partial shipment indicator
6. Split shipment indicator

AT401572502026XAX – 1st Increment
AT401572502026XBX – 2nd Increment
AT401572502026XZX – Last Increment

Figure 5-3. Example of MILSTRIP TCN

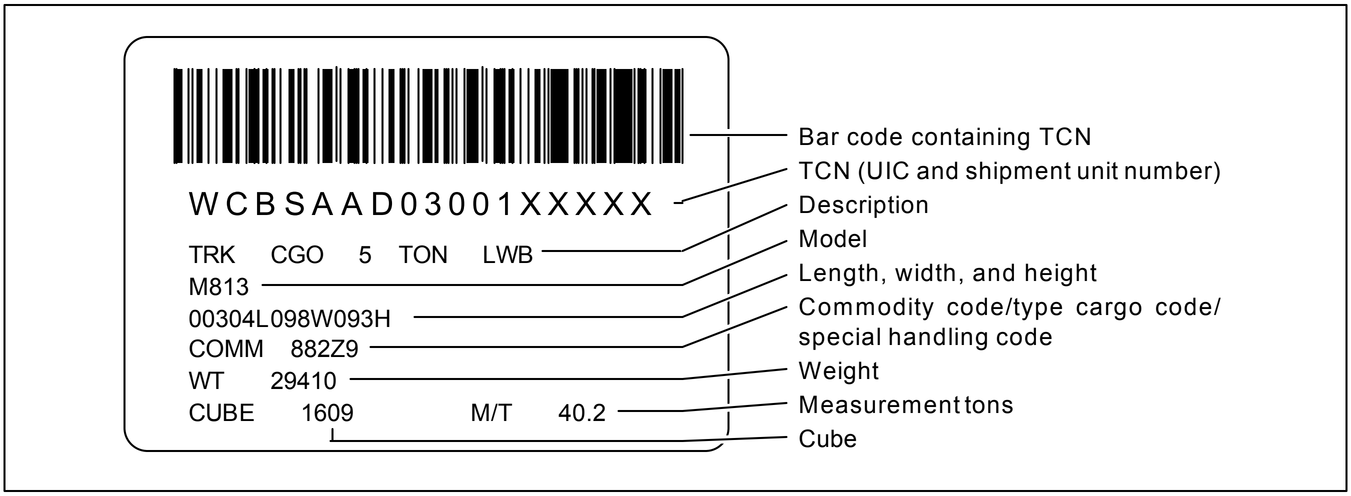


Figure 5-4. LOGMARS label

Since most container vessels have no shipboard cranes to handle containers, container cranes are required. Two or more cranes working simultaneously can load and unload a container ship. The truck entrance to a terminal should have two or three entry lanes with an equal number of departure lanes. A truck scale to weigh containers in or out should be located in each lane. A building is usually located at the entry/ exit point for processing paperwork and assigning positions in the marshaling yard to incoming containers. Approach roads to the terminal should be generous. Container operations generate substantial truck traffic, peaking on days when ships are in port. This peak requires truck-holding lines at the terminal entrance.

Located near the entry building and next to the marshaling area is a small garage for the physical inspection of arriving or departing containers. Inspection is required because responsibility for the containers changes as they enter or leave the terminal. Also, a maintenance garage is usually provided for stevedoring devices used to handle containers in the marshaling yard.

A less-than-container-load packing shed (i.e., a "container freight station") is usually provided. The building need not be next to the marshaling area and definitely should not assume the location of a transit shed. Any structures near the string piece tend to impair movement of containers to and from the cranes during loading and unloading operations. The size of packing sheds varies, but the general configuration resembles a typical truck terminal. Delivery trucks arrive at one side of the building. Cargo is moved from these trucks directly into waiting containers on the opposite side with a minimum flooring of cargo. The packing shed, therefore, tends to be long and narrow with emphasis on the necessary number of truck and container doors.

Storage and retrieval systems. A number of storage and retrieval systems and combinations of systems are used at container terminals. Of these, the most common are chassis storage, the straddle carrier, and the travel crane. Where space is limited, a vertical storage and retrieval system is employed.

With the chassis storage system, a container discharged by a ship is placed on a semitrailer chassis. A yard tractor hauls the chassis to an assigned terminal position. The chassis remains there until picked up by a highway tractor. Highway tractors similarly store chassis-carrying export containers. Yard tractors later haul these containers to the ship. Since containers are stored one-level high, this system requires more terminal storage space than any other container storage system. Handling efficiency is 100 percent because every container is immediately available to a tractor unit, and all required handlings are productive. This system requires more chassis than any other system.

The straddle carrier stacks containers two or three levels high. The carrier straddles the containers and moves them between shipside and storage areas or onto trucks or railroad cars. This system requires less storage space. Handling efficiency, however, is reduced to 50 percent or less because an upper container must be moved to reach a lower container. In some cases the tractor-chassis system is used between shipside and stacking area.

The traveling bridge crane stacks containers up to four high. It can stack higher than the straddle carrier, increasing the capacity for a given area. However, the many nonproductive handlings required to retrieve containers can significantly reduce handling efficiency. Tractor-chassis units deliver containers to and from the cranes.

Materials-Handling Equipment. Proper use of MHE – large, mechanically powered equipment used to lift, transfer, and stack cargo – greatly increases operational efficiency. The equipment discussed here is representative of the types of MHE.

The yard tractor, M878A1 (Figure 5-5) is used primarily to provide a capability to shuttle semitrailers loaded with containers or break-bulk cargo within fixed ports, on prepared beaches during LOTS operations, and in trailer transfer areas.

The 50,000-pound container handler, rough terrain (Figure 5-6) is a rough terrain truck designed to operate on soft soil conditions such as unprepared beaches. It has four-wheel drive and can ford in up to 5 feet of salt water. The RTCH is a modified commercial design vehicle procured to military specifications. It is capable of handling the 8-foot-wide family of containers weighing up to 50,000 pounds. Top handlers are placed on the forks of the RTCH to allow handling of the three different lengths of ISO containers.

The 4,000-pound capacity rough terrain forklift truck (Figure 5-7, page 5-18) is capable of stuffing and stripping the 8-foot-wide family of ISO containers under field conditions. It is sized to effectively operate within the ISO container including two pallet loads side-by-side and two high. The 4K RTFLT weighs about 10,000 pounds, is 79 inches wide, 80 inches high, and 165 inches long, excluding forks. The diesel engine-powered vehicle is four-wheel drive for rough terrain operation and has free-lift and side shift capabilities for operating within the confines of a container.

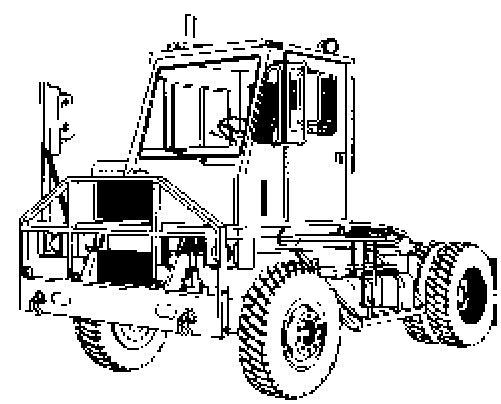


Figure 5-5. Yard tractor

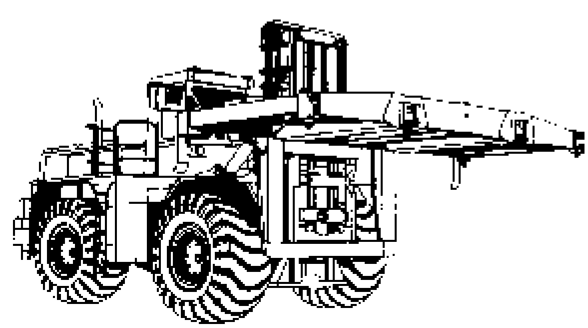


Figure 5-6. Rough-terrain container handler, 50,000-pound

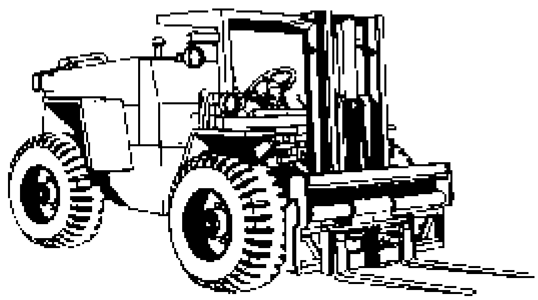


Figure 5-7. Rough-terrain forklift truck, 4,000-pound

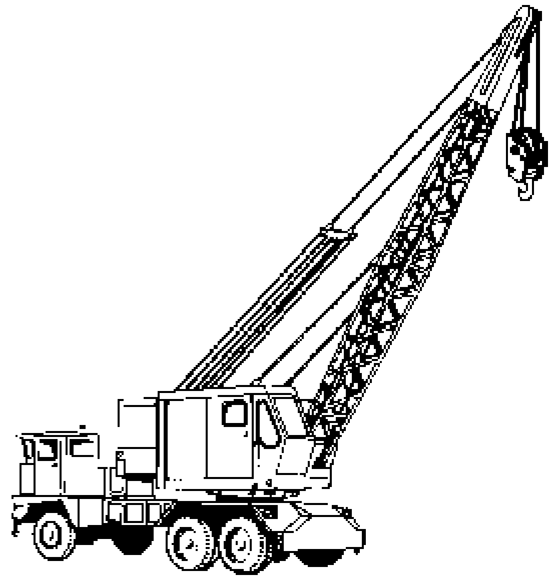


Figure 5-8. Rough-terrain container crane, 20-ton

The rough terrain container crane (Figure 5-8) is a commercially designed wheel-mounted crane. The RTCC can lift a 20-foot container weighing 44,800 pounds at a radius of 27 feet and a 35-/40-foot container weighing 67,200 pounds at a radius of 22 feet.

General support ammunition units use the RTCC from a "fixed position" for transfer of 20-foot ANSI/ISO containers from one mode of transportation to another or to ground/load containers from or to waiting transportation in the theater and corps ammunition storage areas. Transportation units use this crane to augment the 50,000-pound RTCH in the transfer and handling of 20-, 35-, or 40-foot containers and other cargo between transportation modes and in storage areas.

The 140-ton, truck-mounted container handling crane (Figure 5-9) is a commercially designed crane mounted on an 8-by-4-foot truck chassis. It has a 140-ton maximum capacity at a reach of 12 feet. Its 50-foot basic boom can be extended up to 130 feet with the use of various lengths of lattice boom. The 140-ton crane is used to load and unload containers from ships in fixed port operations and to handle containers at marshaling areas and terminal sites. Also, in LOTS operations, it is used on causeway sections to transfer containerized cargo from displacement craft to transport vehicles; and on the beach, to transfer containerized cargo from Hovercraft to the beach.

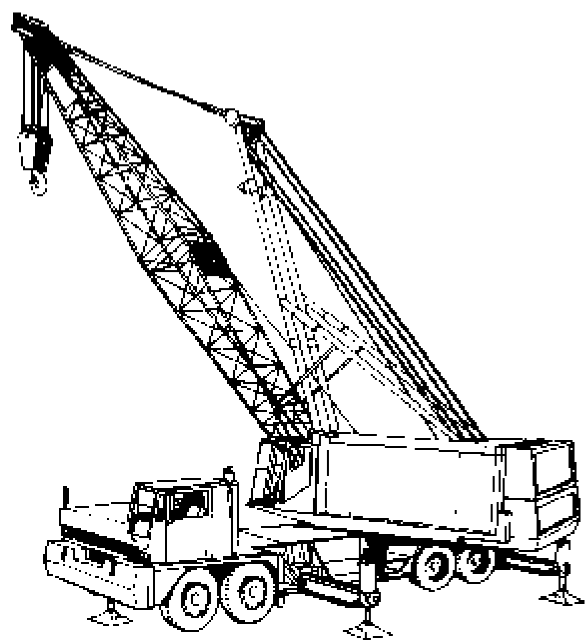


Figure 5-9. Truck-mounted crane, 140-ton

Spreader bars, intermodal container handling. Spreader bars are connected by slings to the hook of a crane (such as the RTCC or the 140-ton truck-mounted container handling crane). They handle ISO and other intermodal containers. The Army has two types of spreader bars: one type handles 20-foot containers and the other handles 40-foot containers. Both have a fixed-frame design and manually locking twist locks.

See Tables 5-6 through 5-10, pages 5-19 through 5-20, for data on gasoline-powered forklifts, rough-terrain forklifts, wheeled warehouse tractors, electric-powered forklifts, and truck-mounted cranes.

Table 5-6. Gasoline-powered forklifts

MODEL NUMBER	LENGTH (in)	WIDTH (in)	HEIGHT (in)	WEIGHT (lb)	LIFT HEIGHT (in)	FREE LIFT (in)	CAPACITY (lb)	TIRE TYPE [1]
FB 20-24 (131)	63 3/4	32	83	4,304	130	12	2,000	S
KC 51T20H-RS53 (156)	70	32 1/2	83	4,134	130	66	2,000	S
MY40RS (170)	97 1/2	60 1/2	90 1/2	8,500	144	57	4,000	P
MY40 (170)	94 1/2	60 1/2	90 1/2	8,500	144	57	4,000	P
G54P-4024RS (166)	92 3/4	63 1/2	91	8,420	144	57	4,000	P
540 RS (160) VI	89 3/4	44	83	10,500	127	57	6,000	S
Yardlift 60 RS (115)	113	68	115	9,705	168	6 3/4	6,000	P
MY 60 RS (171)	110 1/4	70	110 1/2	9,720	168	18 1/2	6,000	P
GLF 100- (163)	110 1/4	53	68	13,200	100	43	10,000	S
Yardlift 150-53RS (151)	152	96	150	22,000	210	2 1/2	15,000	P
H 150C (178)	145	81	152	19,050	210	2	15,000	P

[1] Tire types:
S – solid rubber
P – pneumatic

Table 5-7. Rough-terrain forklifts

MODEL NUMBER	LENGTH (in)	WIDTH (in)	HEIGHT [1] (in)	WEIGHT (lb)	LIFT HEIGHT (in)	POWER	CAPACITY (lb)	TIRE TYPE [2]
Baker RPF060M02 (164)	204	84	96	8,000	78	Gasoline	4,000 RT	P
Anthony MLT6	229 1/2	86	94	16,800	144	Gasoline	6,000	P
MR 100 (173)	228	102	124 [4]	23,800	144	Diesel	6,000 RT	P
—	138 [3]	—	—	—	—	—	—	—
Millicin	244	103	100	30,000	144	Gasoline	10,000	P
—	252	—	133 [4]	—	—	—	—	—
RTL-10	203 [3]	106	—	34,500	142	Diesel	10,000 RT	P

[1] With mast collapsed
[2] P – pneumatic
[3] Less forks
[4] With guard

Table 5-8. Wheeled warehouse tractors

MODEL NUMBER	LENGTH (in)	WIDTH (in)	HEIGHT (in)	SHIPPING WEIGHT (lb)	NUMBER OF WHEELS	DRAWBAR PULL (lb)	TIRE TYPE [1]	POWER
TSSA	89 1/2	41 7/8	62	2,740	3	2,000	S	Electric
MTT-W	79	42	48 1/2	3,500	4	3,500	S	Electric
MW-4-SE	86	42	59	3,545	4	4,000	S	Electric
Clarktor-40-RS	110	65 1/2	56	4,700	4	4,000	P	Gasoline
J-217-E	116	66	62	5,800	4	4,000	P	Gasoline
Clarktor-75	119	69	56 1/2	9,940	4	7,500	P	Gasoline

[1] Tire types:
S – solid rubber
P – pneumatic

Table 5-9. Electric-powered forklifts

MODEL NUMBER	LENGTH (in)	WIDTH (in)	HEIGHT [1] (in)	WEIGHT (lb)	LIFT HEIGHT (in)	FREE LIFT	CAPACITY (lb)	TIRE TYPE [2]
FSHEYG20/48	69 1/2	34 1/4	83	3,808	130	5	2,000	S
Clipper ECE2024SE	64 7/8	34 1/2	83	3,900	130	64	2,000	S
RAT 30 Type E	37 1/4	13	31 1/4	5,130	144	44	3,000	S
FTHEG 40/48	81	41 1/2	91	6,950	144	7 1/2	4,000	S
Carloader SE ELL 4024	77 1/4	41	91	6,613	144	70	4,000	S
FT 60/48	88	47 1/2	83	8,000	127	61	6,000	S
EUT 6024 SE 50	92 1/4	43	133	8,550	168	6	6,000	S

[1] With mast collapsed
[2] S – solid rubber

Table 5-10. Truck-mounted cranes

ITEM	CAPABILITY (STONs)	LENGTH (in)	WIDTH (in)	WEIGHT (lb)	BASIC BOOM LENGTH (ft)
20-ton crane	20 @ 10-ft radius	326	119.0	59,860	30
140-ton crane	140 @ 12-ft radius	873 w/50-ft boom	132.5	195,000 w/120-ft boom	50
250/300-ton crane	250 @ 18-ft radius	570	144.0	370,000 w/160-ft boom	70

Flatracks and Sea Sheds

The majority of merchant ships are container ships, and their carrying capability is limited to containerized cargo. The Navy developed sea sheds and flatracks to enhance this capability.

Sea sheds (Figure 5-10) provide temporary multiple decks for transporting large military and outsize break-bulk cargo that will not fit into containers. Sea sheds for commercial ships are 40 feet long, 25 feet wide, and 12 feet 5 inches high. Each FSS has eight 35-foot sea sheds.

Flatracks (Figure 5-11, page 5-22) are portable open-sided 20- and 40-foot units that fit into existing below-deck container cell guides. Their purpose is to make better use of space on container ships and FSSs when transporting heavy or outsized cargo. See Figure 5-12, page 5-23, for an illustration of sea sheds and flatracks in a containership hold. See FM 55-17 for more information on these systems.

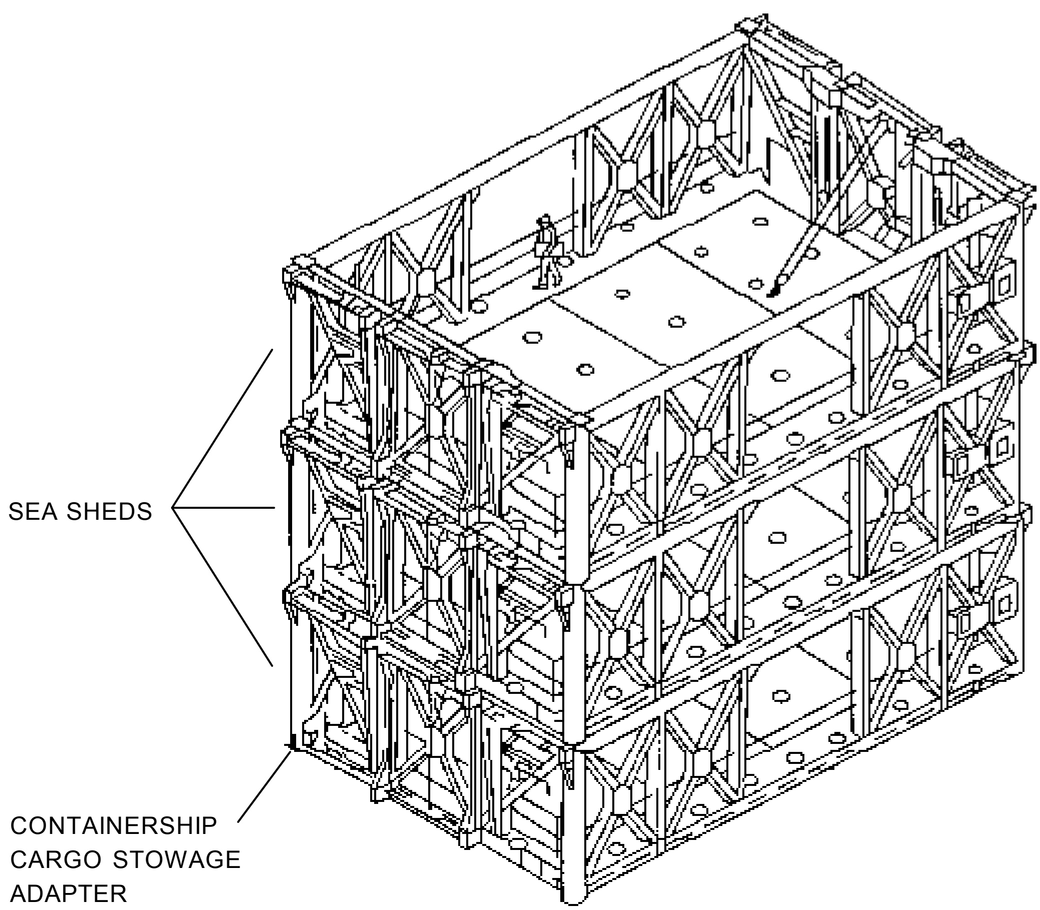
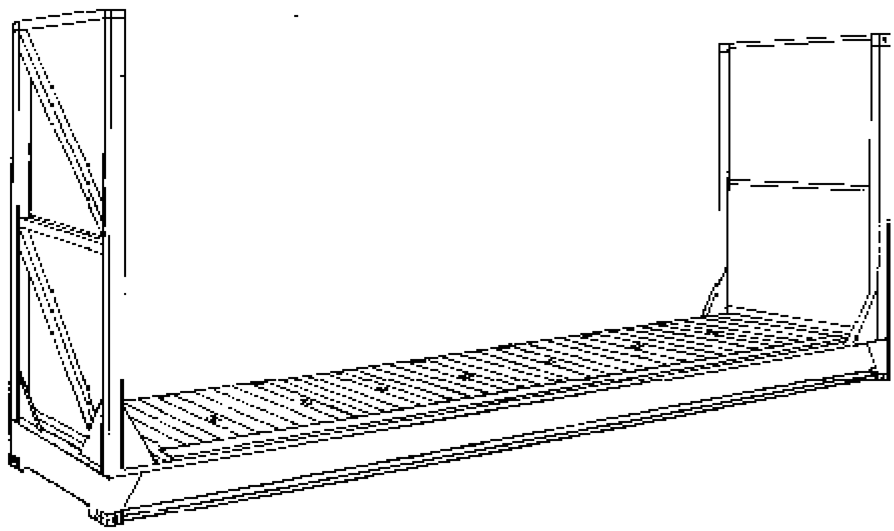
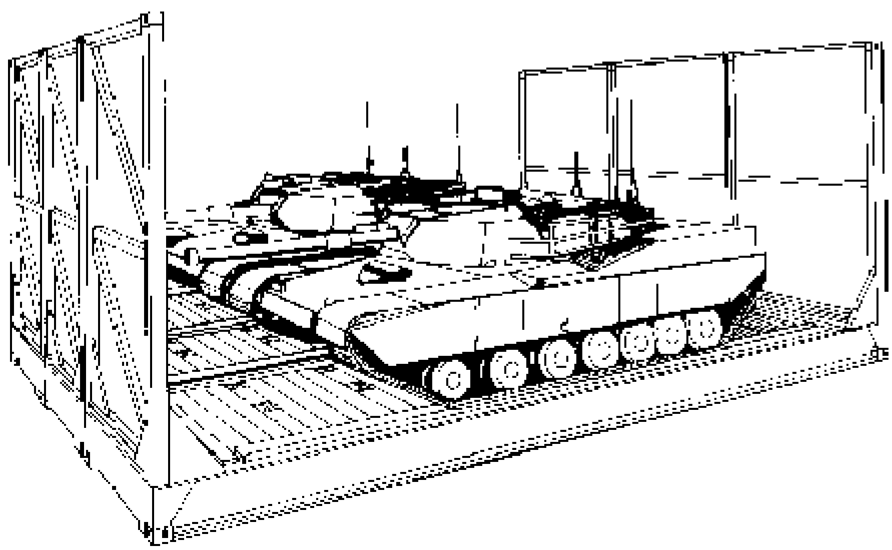


Figure 5-10. Sea shed system



OPEN-TOP, OPEN-SIDED FLAT RACK



FLAT RACKS LOADED WITH M-1 TANKS

NOTE: For illustration only, flat racks are shown outside the cargo cell

Figure 5-11. Flat racks

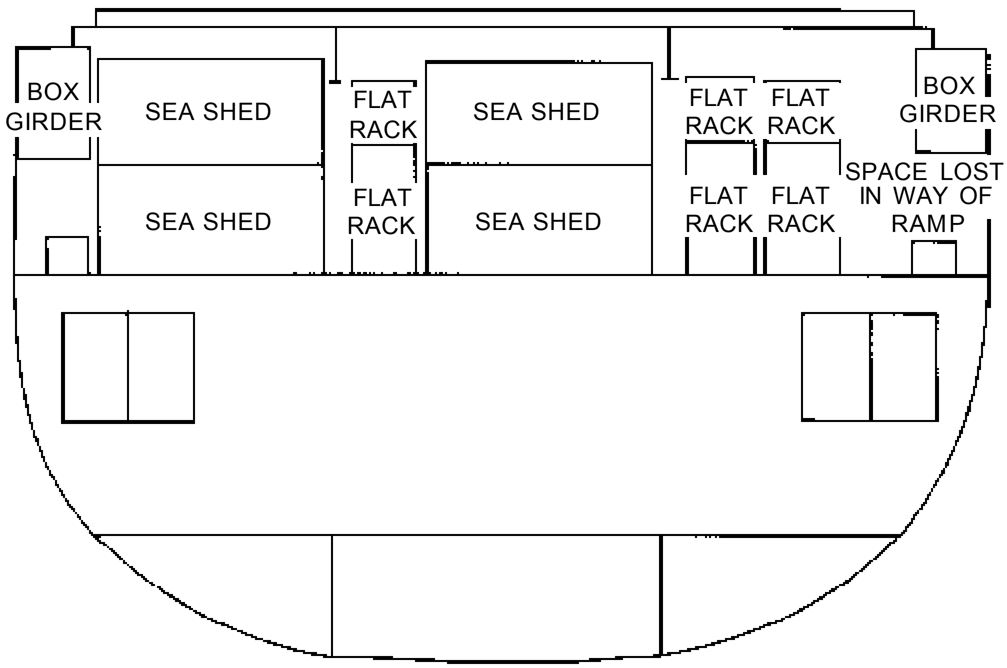


Figure 5-12. Sea sheds and flat racks in containership hold

Equipment Deployment and Storage Systems

Part of the Army containerization master action plan, EDSS are standardized unit deployment/storage systems capable of strategic and tactical delivery by both surface and air transport. The two types of EDSS modules are the ground dominant system (QUADCON) used by units to deploy by sea and the air dominant system (ISU) used by units to deploy by air.

The QUADCON (Figure 5-13, page 5-24) is the primary surface/sea deployment system. It is a lockable, weatherproof, reusable, prefabricated container with a cargo capacity of 8,000 pounds. The QUADCON has a structural steel welded frame. Its top sides and door panels are made of plywood coated with plastic laminate. The floor is of high density plywood covered on both sides with sheet steel. It has double doors on each end and ISO corner fittings for lifting and restraint. The QUADCON base allows four-way forklift entry. It can be shipped as a single unit or divided into four components for transport by unit organic assets. Four containers locked together have the same dimensions as a standard 20-foot intermodal ANSI/ISO container and are compatible with the 20-foot cell guides of a container-ship. For information on the ISU, see Chapter 2 of this manual.

LENGTH: 96"
WIDTH: 57"
HEIGHT: 82"
CARGO CAPACITY: 8,000 LB
GROSS WEIGHT: 10,000 LB

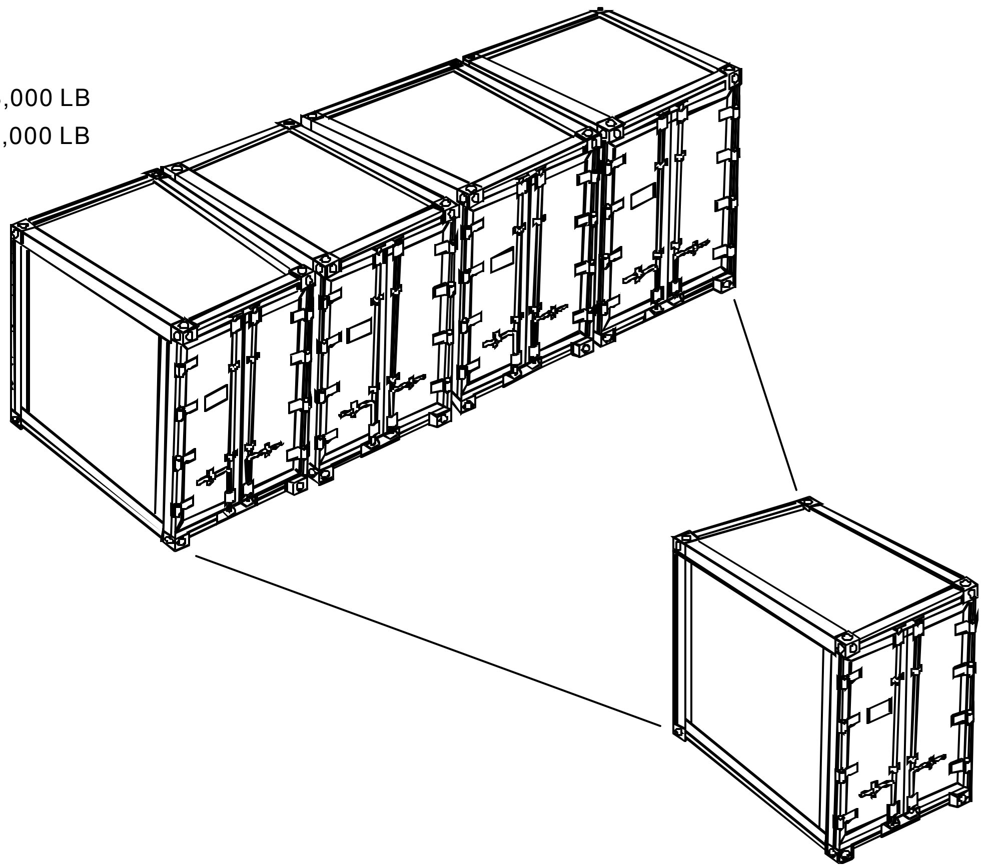


Figure 5-13. QUADCON surface/sea deployment system

MILVAN. The 8- by 8- by 20-foot MILVAN (Figure 5-14, page 5-25) is used to transport and temporarily store military cargo. It is of steel construction with hardwood floors and walls lined with plywood. This demountable container has a significant weight and cube capacity and can be moved by all modes of transportation. However, it cannot be handled by forklift. MILVAN containers can be obtained through the ITO, and any movement of these containers must be coordinated with the ITO.

Pallets. Four basic types of pallets are used for loading cargo into containers and for other cargo handling operations. They are the general purpose pallet, sled pallet, stevedore pallet, and warehouse pallet.

The general-purpose pallet (Figure 5-15, page 5-25) is a four-way-entry wooden pallet. It is 48 inches long by 40 inches wide by 5 1/2 inches high. It is used primarily to ship palletized cargo and often accompanies cargo from shipper to consignee. The four-way-entry feature facilitates easy entry by forklift.

The sled pallet (Figure 5-16, page 5-25) is a heavy, timbered platform with runners and cables attached to allow towing. Up to 3,000 pounds of supplies and equipment can be secured to the pallet with steel bands. The pallet alone weighs about 200 pounds. Sled pallets may be moved through any surf or over any beach accessible to landing craft or equipment.

OUTSIDE
LENGTH:20’ 0”
WIDTH: 8’ 0”
HEIGHT: 8’ 0”

INSIDE
LENGTH:19’ 4”
WIDTH: 7’ 6”
HEIGHT: 7’ 1”
CARGO CAPACITY:41,300 LB
EMPTY WEIGHT" 3,500 LB

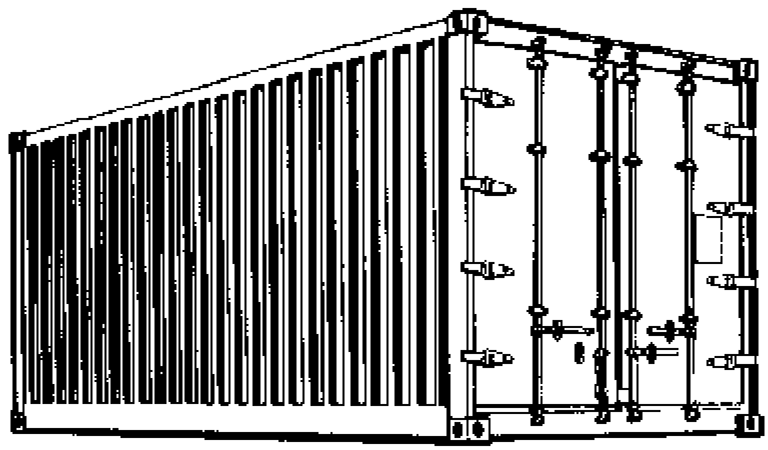


Figure 5-14. MILVAN characteristics

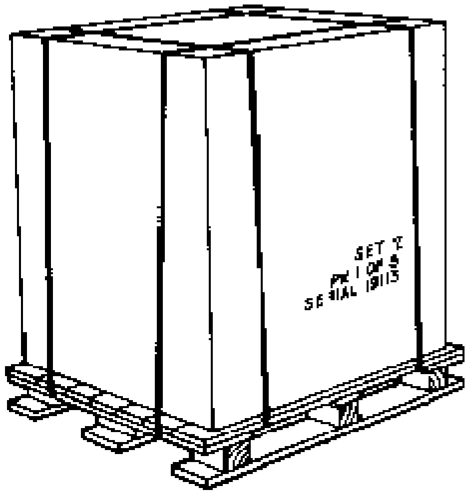


Figure 5-15. General-purpose pallet

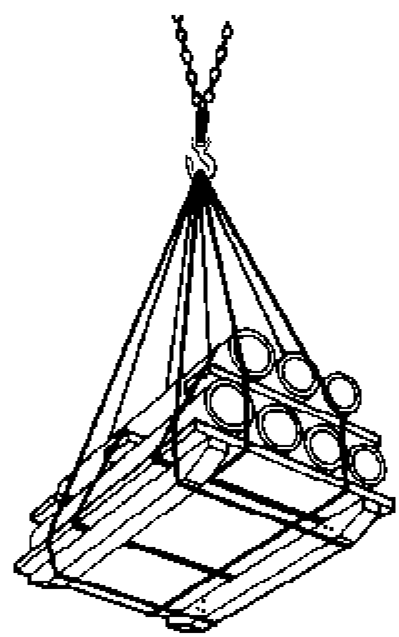


Figure 5-16. Sled pallet

The stevedore pallet (Figure 5-17) is a reversible pallet used to handle loose cargo at water terminals. The standard stevedore pallet is 4 feet wide by 6 feet long by 8 inches high. The stringers are made of 3- or 4-inch lumber. The deck boards are made of 2-inch-thick lumber. The outside or end boards should not be less than 6 inches wide. The inside boards may be random widths. The outside stringers are set in 4 to 6 inches from the ends so that a pallet bridle may be inserted. The inside stringers are arranged to allow easy entrance of forks for movement by forklift trucks.

The warehouse pallet is used to handle cargo in warehouses. It is much lighter than the stevedore pallet. The most common size of warehouse pallet is 48 by 48 inches, but a 40- by 48-inch size is also made. It is either of the open-end type (moved by a forklift or hoisted by a pallet bridle) or the closed-end type (moved by forklift only).

When items of cargo are palletized, the tiers are laid so that they tie together with each other to give stability to the entire load. This method keeps the cargo from falling off the pallet while in transit. Building the load in a definite pattern facilitates maximum use of the pallet area. Rations, water, fuel in 5-gallon containers, and ammunition are the supplies most suitable to pallet loading.

INLAND WATERWAY PLANNING

An IWW is usually operated when there is an established system of connecting rivers, lakes, inland channels, protected tidal waters, and canals that can extend the theater transportation system from deep-draft ports to inland discharge points. IWWs complement existing transportation networks and reduce congestion and work loads of other transport modes. They are principally used by the civilian economy. Factors governing the military use of IWWs include:

- Degree of waterway development.
- Rehabilitation required.
- Tactical situation.
- Impact on civilian economy.

Watercraft most commonly used on an IWW include the LASH and SEABEE; locally available self-propelled barges; and US Army barges, tugs, and landing craft (Figure 5-18, page 5-27). Use of HN craft should be strongly considered since these vessels are tailored to the country's waterway system.

Inland Waterway Service

When needed, an IWW service can be formed to control and operate a waterway system, plan and coordinate the use of IWW transport resources, and to integrate and supervise local civilian facilities that support military operations. This organization may vary in size from a single barge crew to a complete IWW service. It may be composed entirely of military personnel or staffed by local civilians supervised by military units of the appropriate transportation staff.

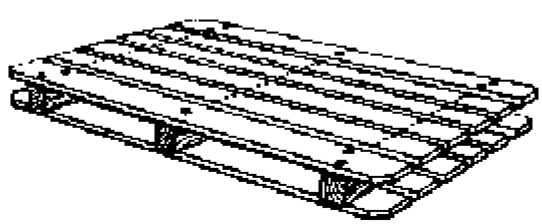


Figure 5-17. Stevedore pallet

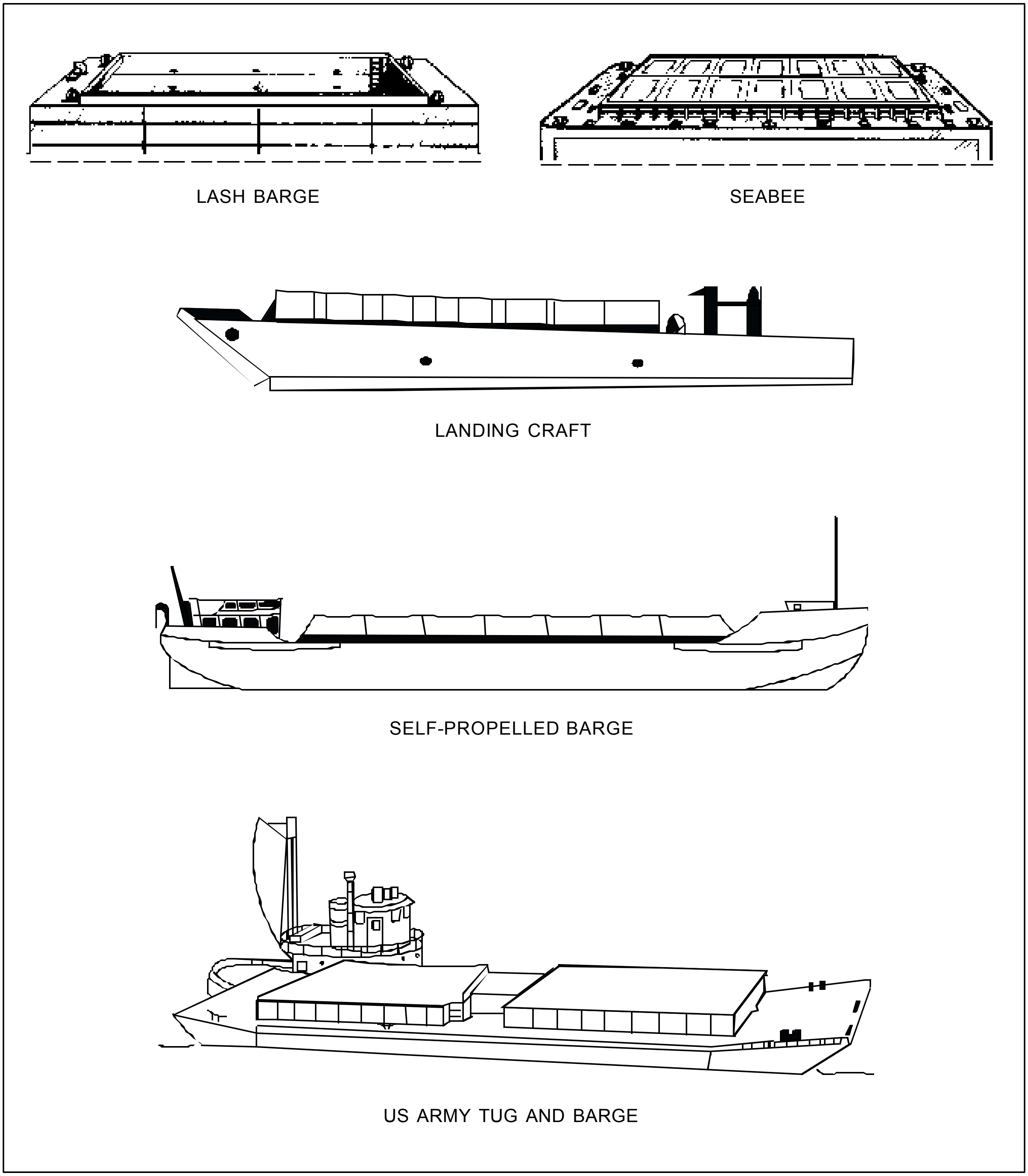


Figure 5-18. Lighters used on an inland waterway

Inland Waterway System

Three separate functional components – the ORP, the IWW, and the IWW terminal – make up the IWW system (Figure 5-19). The US Army Corps of Engineers operates and maintains the IWW in a generic theater or CONUS. However, developed systems in overseas theaters are normally maintained and operated by the host country.

Ocean reception point. The ORP consists of mooring points for ships, a marshaling area for barges, and a control point. At least two stake barges should be at each ORP – one for import cargo and one for export. LASH, SEABEE, container, and general cargo vessels may discharge at an ORP.

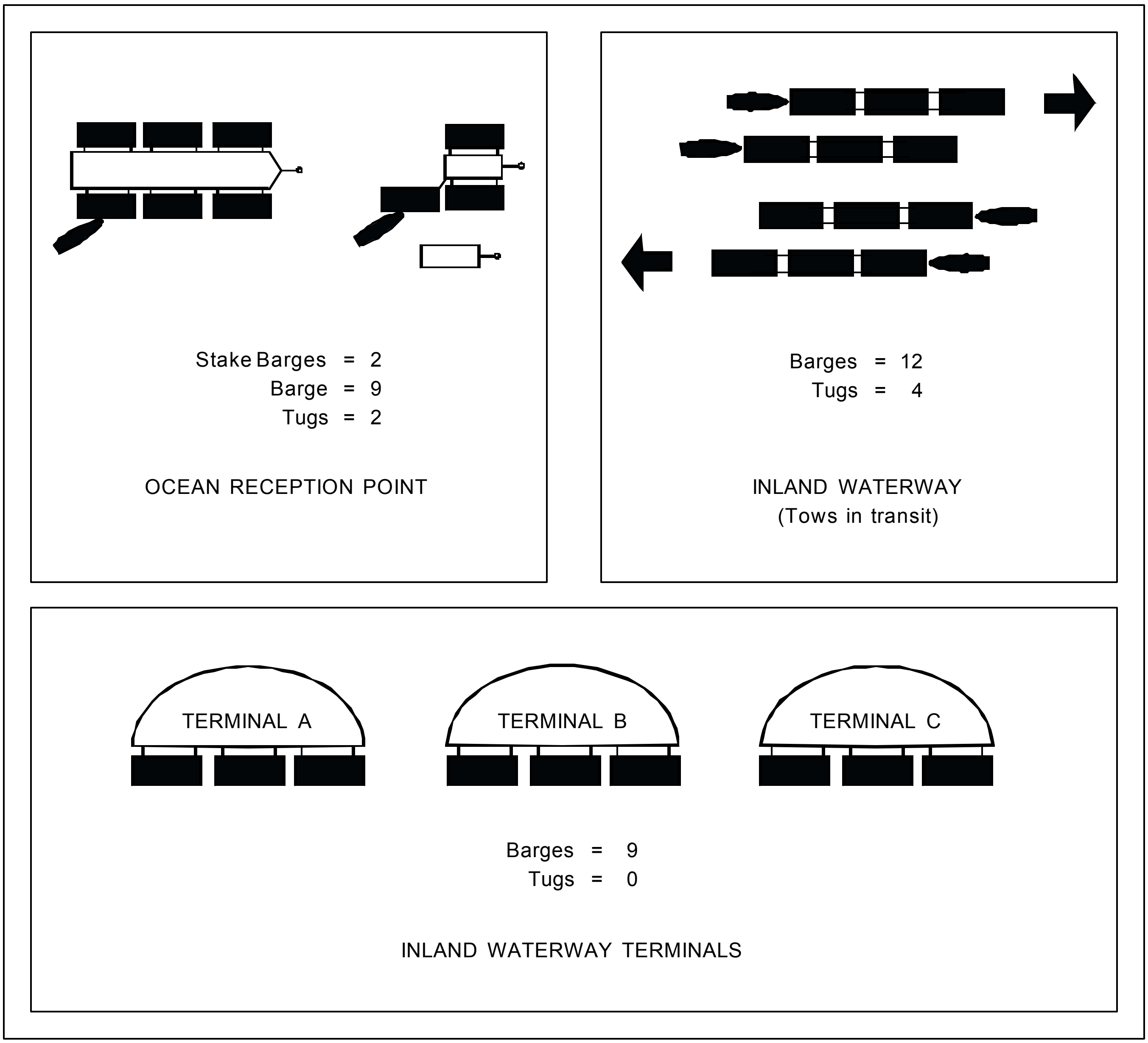


Figure 5-19. Inland waterway system

Inland waterway terminal. At the IWW terminal, cargo is transferred between lighters and land-based transportation. Terminals are established at the origin and terminus of the inland water route. Intermediate terminals are located along the way wherever a change in transport mode is required. Terminals in an IWW system are classified as general cargo, container, liquid, or dry bulk commodity shipping points. With one exception (general cargo), terminals usually include special loading and discharge equipment that allows rapid handling of large volumes of cargo. See Figure 5-20 for types of IWW terminals and Figure 5-21, page 5-30, for a typical inland barge terminal.

Planning Factors

Transportation planners are interested in the waterway's capability to move cargo. Physical features that affect this ability include the width and depth of the channel; horizontal and vertical clearance of bridges; and number of locks, method of operation, and time required for craft to clear them. Also, planners must know the type and duration of the area's seasonal restrictions (i.e., freeze-ups, floods, droughts). Other concerns are the speed, fluctuation, and direction of water current and the availability of craft, labor, facilities, and maintenance support.

To determine capacity for the entire system, planners compute the capacity of each functional component. The least of these is used as the estimated capacity. For example, if the capacity per day is 3,000 tons (ORP), 2,000 tons (IWW), and 2,500 tons (IWW terminal), the capacity for the IWW system is 2,000 tons. Once this is established, personnel requirements for each component can be determined. See FMs 55-50 and 55-60 when planning personnel and unit requirements for an IWW system.

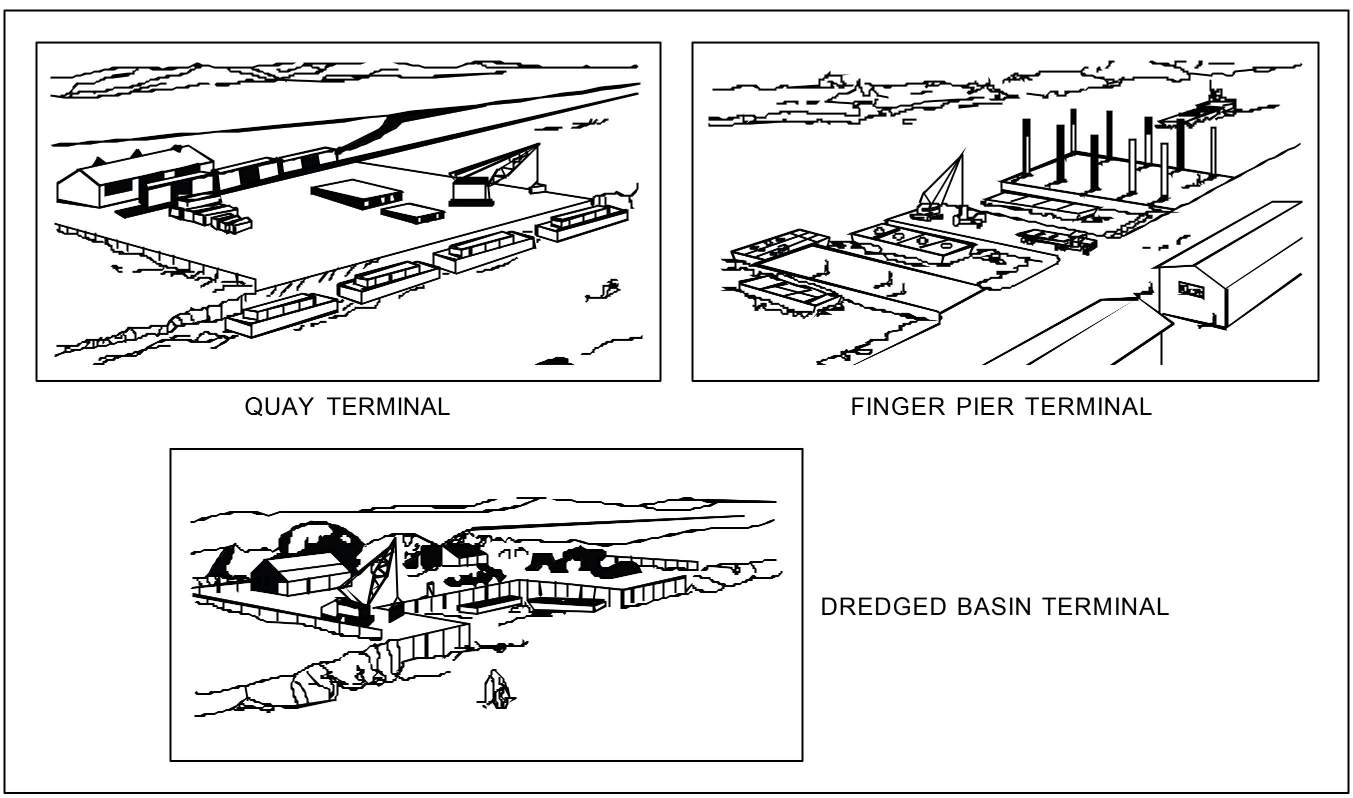


Figure 5-20. Types of inland waterway terminals

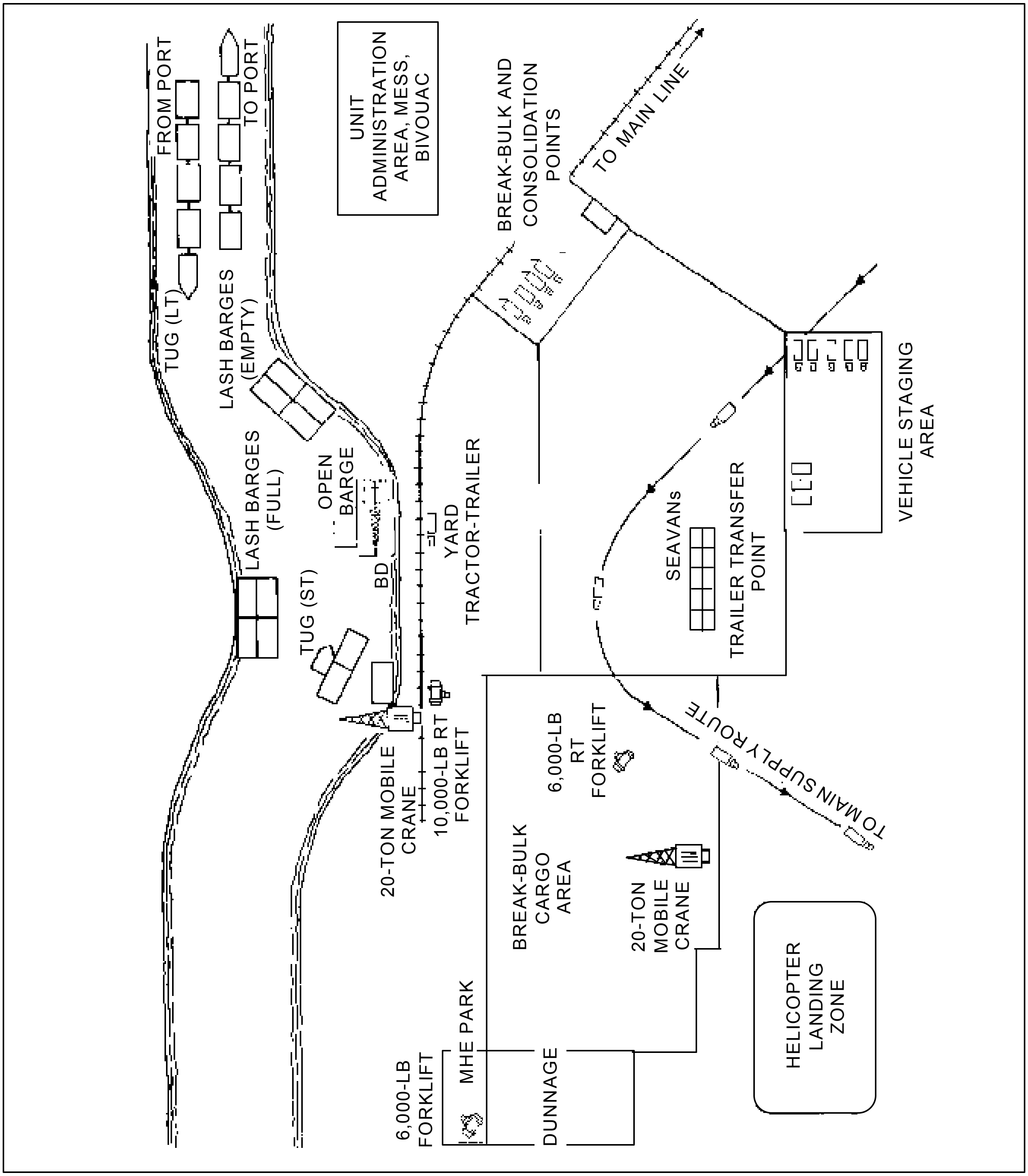


Figure 5-21. Typical inland barge terminal

LOGISTICS OVER-THE-SHORE PLANNING

A LOTS operation may be conducted as part of the base, garrison, or theater development that immediately follows an amphibious operation or as a separate evolution when no amphibious operation precedes it. It can be supported by or coordinated with other services (JLOTS). During LOTS operations, supplies and equipment are moved ashore and transferred to a transportation agency for onward movement. Because LOTS operations are inherently dangerous, risk assessment and risk management are ongoing requirements. Planners should be familiar with the following terms:

- In-the-stream anchor – describes an operation where a deep-draft vessel is anchored in protected deep waters, such as a harbor.
- Offshore anchor – anchorage off the shoreline in unprotected deep water.

From either of these anchorages, ships can discharge to lighters for subsequent discharge to a fixed-port facility, unimproved facility, or bare beach. Figure 5-22, page 5-32, depicts a LOTS operation.

Major or Secondary Port Operations. Certain conditions require a LOTS operation through major or secondary ports. If, for example, port facilities are denied to deep-draft shipping as a result of enemy action, a LOTS operation would be the alternative. Other circumstances requiring LOTS include inadequate port berthing capability or inadequate port facilities due to shallow water depths and/or enemy action.

Bare Beach Operations. LOTS operations across a bare beach are the most resource-demanding in terms of the type and number of watercraft required. In many areas, the capacities of existing ports are not adequate to support theater tonnage requirements. This factor, along with the possibility of enemy insurgent activities, requires that plans favor widely scattered beach operations over large port complexes. Nearly 40 percent of all cargo entering a theater by surface means is delivered through dispersed beach terminals. Therefore, the theater's senior terminal commander must continually plan for and open new beaches. These sites accommodate increased tonnages and replace the tonnage capacity of a port or unimproved facility that has been made untenable by enemy actions. Plans should include–

- Proposed location and layout of the area.
- Type of lighters to be used.
- Task organization required to attain the desired tonnage capacity.
- Route and methods of movement to the area.
- Construction effort required.
- Communication requirements and logistical support procedures.

Site selection. The first step in planning beach operations is to determine the areas available. It is hard to find beaches that are ideally suited to LOTS without preparation or modification. Engineer support is usually required for landing craft to beach and to provide exits from the beach to discharge areas and the clearance transportation net. The degree of dispersion that can be attained relates directly to daily tonnage requirements and the size and nature of the assigned area. The existing capability to accommodate desired tonnage should be the basis for site selection. Major factors to consider when selecting beach discharge sites include:

- Beach characteristics.
- Tidal range.
- Weather.
- Surf.
- Topographic features.

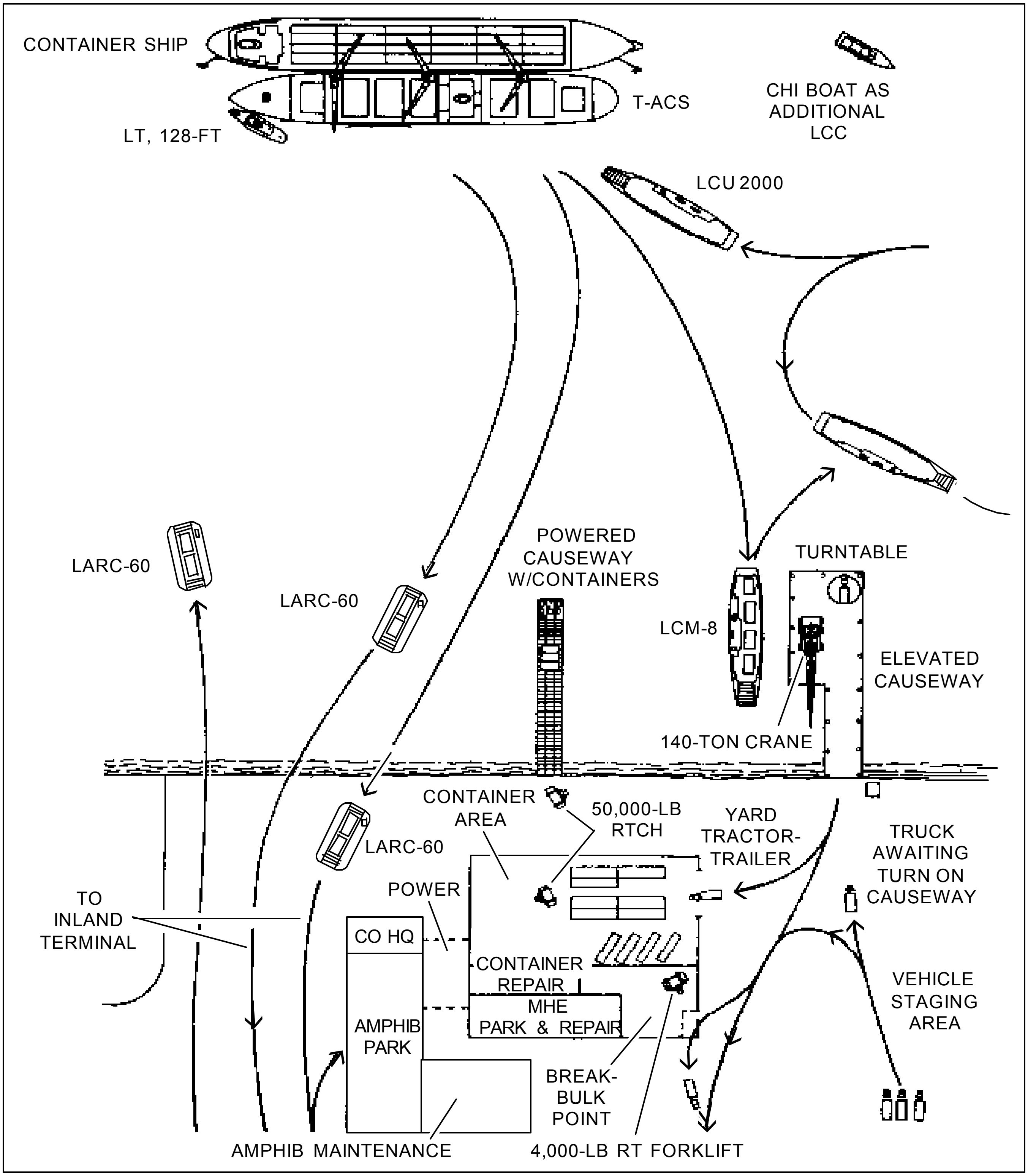


Figure 5-22. Typical LOTS operation

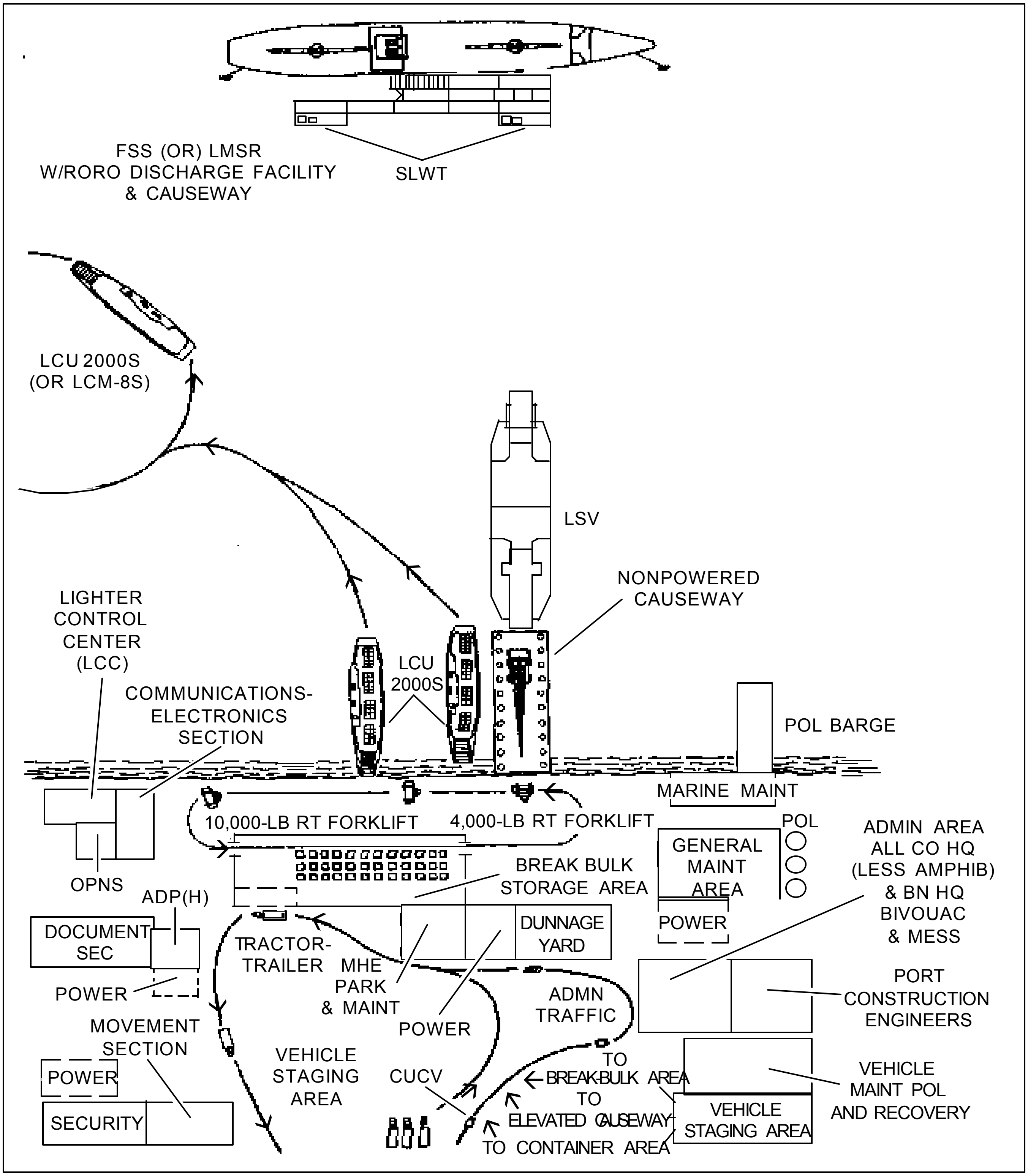


Figure 5-22. Typical LOTS operation (continued)

The terminal group or brigade commander, in coordination with the Navy and MSC, generally selects possible beach sites for LOTS operations. Selection is based on extensive study of maps and hydrographic charts and analysis of aerial reconnaissance reports. Aerial reconnaissance verifies information obtained from maps and charts. For example, roadnets shown on maps may have been destroyed or made impassable, and new roads may have been built. Bridges may have been destroyed, or structures may have been built on the beach. A detailed ground and water reconnaissance of the selected area also aids in determining site feasibility. The reconnaissance should be as thorough as time and circumstances allow. It is crucial that naval authorities be consulted early in the study. This ensures that advice about possible anchorage areas, along with difficulties and hazards to navigation, are available as early as possible.

Reconnaissance. Personnel who conduct ground and water reconnaissance must be qualified to advise the terminal group commander on the following:

- Engineering effort required to prepare and maintain the area.
- Signal construction and maintenance required for communication within the beach area and between the beach and terminal group headquarters.
- Need for and location of beach dumps, transfer points, and maintenance areas.
- Type of lighters that could be most effective.
- Need for and location of lighter safe-haven facilities.
- Location and desirability of anchorage areas.
- Possibility of using modular causeway system, RRDF, and other special equipment.
- Vulnerability of terminal area to enemy attack, its seaward approaches, and its connections with the interior.

To meet these requirements, the reconnaissance party should include:

- Representatives of the terminal group (to coordinate or supervise the reconnaissance team and to recommend task organization).
- Military police representative (to plan support for traffic control and beach management).
- Terminal battalion commander and operations officer (to select and assign company areas and frontages, indicate areas of defense responsibility, and organize area of operations).
- Engineer and signal officers (preferably from supporting engineer/signal units).
- Representatives of terminal service, boat, and amphibian companies involved (to advise and recommend on factors and conditions that affect their units' use).
- Representatives from the US Navy (to advise on anchorage areas and naval support required).

When NBC operations are suspected, the reconnaissance party conducts radiological monitoring, surveys, and chemical agent detection activities to determine possible contamination of prospective beach sites.

Beach characteristics. By gauging beach characteristics, the reconnaissance party can determine if the selected area has adequate anchorage for the number and types of ships needed to support operations. Also, lighters must be able to cross from the anchorage areas to the beach without confronting obstacles. For example, sandbars or reefs just offshore may preclude the use of LCMs, LCUs, or barges. Such conditions may require the use of amphibians until a channel is cleared. Important features to consider are depth, size (including length and width of beach), underwater obstacles, and beach gradient and materials.

Depth. Large cargo ships require a minimum depth of 30 feet and a maximum depth of 210 feet. Minimum depth is determined by the maximum draft of ships to be discharged, the ground swell discharged, and ground swell conditions. The length and weight of the anchor chain determine maximum depth.

Size. To provide a safe, free-swinging area for the standard five-hatch vessel, the anchorage area should be a circle with an 800-foot radius. If larger vessels are anticipated, use the following formula:

$$2\,(7D + 2L) = R \text{ (diameter in feet)}$$

where:

D = depth of water in feet
L = length of vessel in feet

Bow and stern mooring is not considered desirable in tidal areas because athwartship currents cause excessive strain on mooring gear. Also, appreciable changes in depth require continuous watching of the anchored vessels.

Underwater obstacles. Sandbars, shoals, reefs, rocks, ship wrecks, and enemy installations can be a serious menace and interfere with the passage of vessels to and from the area. Consider the potential for interference and the amount of work needed to clear channels.

Beach gradient and materials. Beach gradient, or the underwater slope of the beach, is usually expressed as a ratio of depth to horizontal distance. A gradient of 1 in 50 indicates an increase in depth of 1 foot to every 50 feet of horizontal distance. For landing and amphibious craft, usually only the gradient from the water's edge seaward to a depth of 3 fathoms (18 feet) must be determined. A gradient slightly steeper than 1 in 50 is considered suitable for a loaded LST; a gradient of 1 in 20 suitable for a LCM-8. Beach gradients are classified as follows:

- Steep – More than 1 in 15 feet
- Moderate – 1 in 15 to 1 in 30 feet
- Gentle – 1 in 30 to 1 in 60 feet
- Mild – 1 in 60 to 1 in 120 feet
- Flat – Less than 1 in 120 feet

See Figures 5-23 and 5-24 for profile views of beach sites.

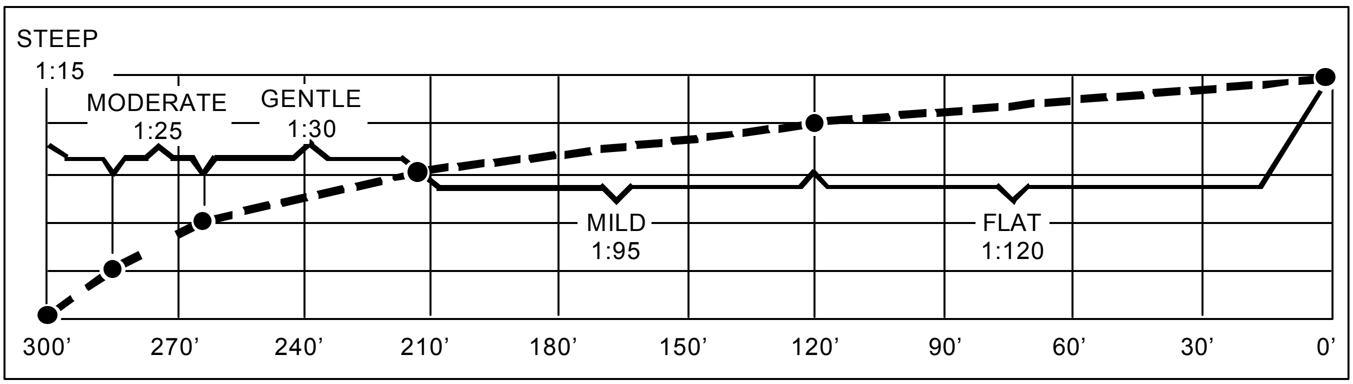


Figure 5-23. Profile view of typical underwater gradient

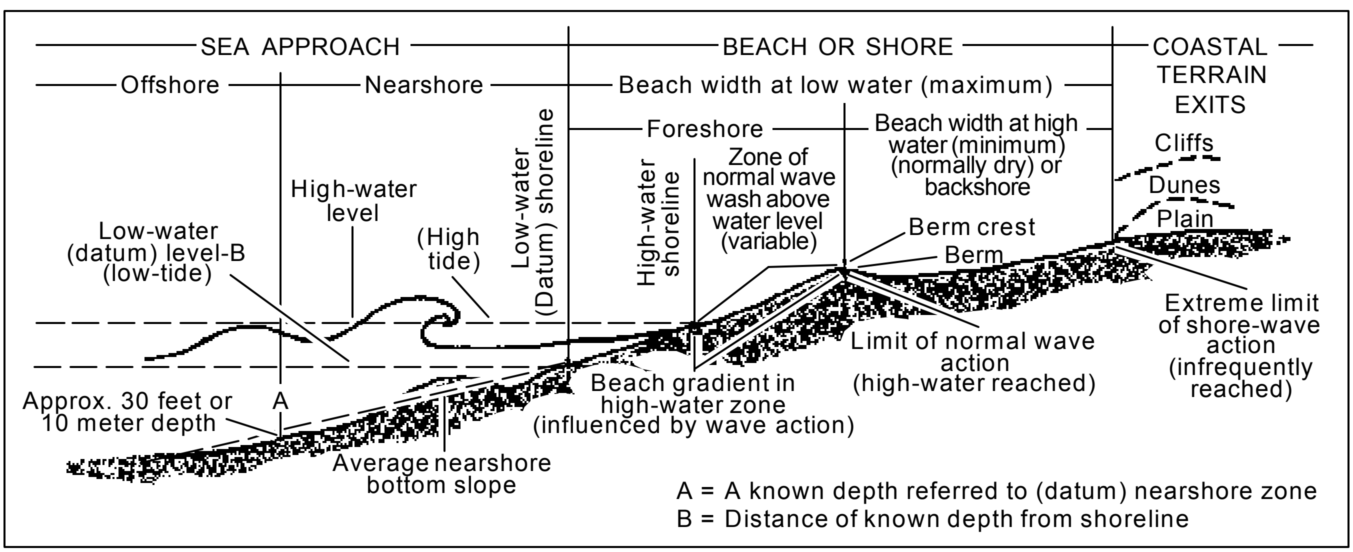


Figure 5-24. Marine beach profile diagram

Beaches are classified by their predominant surface material. The ideal composition for beaching landing craft and amphibians is a combination of sand and gravel. Silt, mud, or fine sand may clog watercraft cooling systems. Rock, coral, or boulders may damage the hull or the underwater propulsion and steering mechanism.

Firm sand provides good beach trafficability for personnel and vehicles. A beach is usually firmest when it is damp and the material is of small size. Gravel has good bearing capacity but poor shear strength. As a rule, the coarser the material, the poorer the trafficability. See Table 5-11 for classifications of beach materials.

Tidal range. The tidal range, the difference in height between consecutive high and low waters, should be considered when selecting a beach site. Other considerations include the strength and direction of tidal stream (rip and littoral currents).

Weather/surf. Favorable weather is critical to a LOTS operation. Rough seas restrict the speed and maneuverability of watercraft. Normal control and coordination problems become more complex. Lighter operations alongside a vessel are particularly hazardous if more than a moderate sea is running. Heavy surf reduces the amount of cargo that lighters can carry and can cause an operation to be suspended. Wind velocity, the distance spanned by the wind, the duration of the wind, and decay distance influence swell and surf functions.

Topographic features. The useful capacity of the beach can never exceed roadnet capacity. If an early and detailed analysis of the existing roadnet reveals that the roadnet capacity is inadequate, new roads must be built. This requires added engineering support for construction and maintenance.

Beach exits. The number of exits needed varies according to physical characteristics of the roads, the type and amount of cargo, and the type of conveyance used in beach clearance. Different types of equipment require separate routes. The adjacent area may limit the number of possible exits from the beach. An otherwise ideal beach may be backed by sand dunes, seawalls, swamps, or other obstacles that hamper endurance operations.

Table 5-11. Beach material classifications by particle diameter

MATERIAL	PARTICLE DIAMETER In Microns*	PARTICLE DIAMETER In Inches
Boulder	256,000 and over	10.24 and over
Cobble	256,000 - 64,000	10.24 - 2.56
Stone	64,000 - 4,000	2.56 - 0.16
Pebble	4,000 - 2,000	0.16 - 0.08
Very coarse sand	2,000 - 1,000	0.08 - 0.04
Coarse sand	1,000 - 500	0.04 - 0.002
Medium sand	500 - 250	0.002 - 0.001
Fine sand	250 - 125	0.001 - 0.0001
Very fine sand	125 - 62.5	0.0001 - 0.0000625
Silt	62.5 - 3.9	0.0000625 - 0.0000156

* Micron is approximately 0.00003937 inch.

Hinterland. Besides the beach and its exits, a number of factors should be considered when selecting a beach for unloading cargo. These other factors include:

- Existing roadnet or railnet.
- Physical characteristics of existing roads.
- Strength and width of bridges in the existing roadnet.
- Possibility of building a roadnet (if none exists).
- Existing lines of communication.
- Suitable area for heliport (if needed).

Landmarks. Landmarks, especially those assisting navigation and location of beaches (such as prominent hills) are helpful.

Beach transfer points. Beach transfer points are locations where cargo is transferred from amphibians to a clearance mode for delivery to destination. The requirement for beach transfer points is identified and their locations designated during reconnaissance.

Cargo clearance. The problems of cargo clearance in beach operations are generally the same as in conventional port terminals. Physical differences in the operating areas, however, may require different procedures and equipment. Ideally, clearance transportation capacity is balanced with discharge capability. This balance ensures that cargo is moved through and out of the terminal area as fast as it is unloaded from the ships. Generally, however, some cargo backlog must be anticipated, creating the need for temporary in-transit storage areas.

In-transit storage areas should be established near transfer points to accommodate cargo that cannot be immediately transferred to clearance conveyances. Cargo unloaded from landing craft that cannot be immediately cleared should also be brought to in-transit storage areas. This avoids congestion and cargo pileup on the beach.

When clearance transportation becomes available to move cargo from the in-transit storage areas, an additional burden is imposed on the terminal service companies that unload lighters. Any effort by these units to handle cargo in the in-transit storage areas only impairs their ability to keep the lighters moving. Eventually, the entire operation stagnates. The problem can be solved by assigning terminal transfer elements (squads, platoons, or companies) to load the backlogged cargo onto clearance transportation. Cargo will then flow out of the terminal without disrupting vessel discharge operations.

Temporary in-transit storage areas should be located away from main clearance roads to minimize road congestion and present less lucrative targets. Roads leading from main clearance roads to in-transit storage areas must be kept in good condition. Each area should have a separate entrance and exit. If tracked vehicles are used as well as trucks and amphibians, separate traffic nets may be needed. The ground should be level, firm, and dry. The surrounding area should be large enough to allow in-transit storage facilities to expand to meet the maximum requirements anticipated.

Traffic control is vital to prevent congestion in the terminal area and to promptly clear cargo to its initial destination. Careful planning to control vehicular traffic in the beach area includes scheduling enough drivers, MHE, and supervisors for around-the-clock operations.

FMs 55-50 and 55-60 discuss LOTS operations in detail.

Shore-to-Shore Operations

Shore-to-shore operations use Army landing craft and amphibians to transfer cargo from one beach terminal to another along the same coastline. See FM 55-50 for information on shore-to-shore operations.

STRATEGIC SEALIFT REQUIREMENTS

Today's Army is a CONUS-based force with global responsibilities. Strategic sealift is critical to meeting the significant mobility challenges of projecting and closing the force within ASMP required time lines. Responsibility for strategic sealift is shared by MSC, MTMC, and MARAD. More than 70 strategic sealift ships transport military equipment, supplies, and POL to support US forces overseas. This number is expandable and includes both government and privately owned vessels, mainly tankers, and dry cargo ships. In peacetime, more than 95 percent of DOD cargo is transported on US flag ships. The Army's strategic sealift requirements fall into three categories: surge, prepositioned, and sustainment.

Surge Ships

During the initial phases of a contingency operation, surge ships transport critically needed equipment such as tanks, trucks, armored vehicles, and helicopters. Our current surge capability includes 8 FSSs and 22 RRF RORO ships. The RORO ships are maintained in either a 5-, 10-, or 20-day readiness status by MARAD at RRF sites or designated outports. This force was established in 1984-85 when DOD recognized that the demand for surge sealift exceeded MSC availability, voluntary charter, and US flag ships.

Prepositioned Ships

The elements of our ASMP triad are sealift, airlift, and prepositioned afloat. Prepositioned afloat is the expanded reserve of equipment and supplies for an armored brigade aboard forward deployed prepositioned ships. The equipment on these ships is designated AWR-3. The program's concept is to forward deploy the equipment and link it up with its complement of troops at the SPOD. The following vessels (14 total) currently make up the PREPO fleet:

- RORO ships from the RRF (7).
- Auxiliary crane ship (1).
- Barge carriers (3).
- Heavy lift ship (1).
- Container ships (2).

LMSRs are scheduled to replace the current RORO ships by 1998. The end state for AWR-3 is 16 ships. The equipment stowed on the PREPO ships includes:

- Combat equipment (with required support and 15 days of supplies) comprising a combat force of a heavy brigade tailorable to a theater commander's need.
- Limited port opening capability.
- Thirty days of sustainment supplies to support the contingency force until the sea lines of communication are established.

Every PREPO ship has a battle book that provides an overview of the AWR-3 program, detailed information on the ship, and the stow plans. PREPO operations may consist of the employment of one ship to support a humanitarian assistance mission to the employment of all ships. FM 100-17-1 is the Army manual for prepositioned afloat operations.

Sustainment Ships

Sustainment ships maintain the supply pipeline with arms, equipment, POL, food, and other materials needed for continued presence in overseas areas. This requirement is filled by ships from US/foreign flag ships and the RRF. Presently, US flag ships number 255 and foreign flag ships, 114. Under a voluntary charter, US flag ships are expected to be available when notified of a contingency.

General Vessel Types

The MSC publishes a semiannual "Ship Register," short title MSC-P504. This unregistered document provides a by-name listing of each US Navy ship operated by MSC and each US flag oceangoing merchant ship, over 1,000 gross tons, owned by the United States or its citizens. It includes information such as class, speed, gross tonnage, draft, and range. Ships are referenced in three main groups:

- Alphabetical listing of US Navy ships.
- Alphabetical listing of merchant ships in operating status including ships undergoing repair or temporarily out of service.
- Nonoperational ships in the NDRF maintained and preserved for purposes of national defense by MARAD.

Anyone needing this document should write to Commander, Military Sealift Command (COMSC), Washington DC 20398-5100; or call the Requirements and Analysis Branch (N3113), 202-433-0087/0092, DSN 288-0087/0092.

The ships discussed in this section are those most commonly used by DOD.

Fast sealift ship. During the 1980s, the US Navy acquired eight large container ships from the SeaLand Corporation. These ships could operate on any major trade route at an unusually fast, sustained speed of 33 knots. They could carry more than a thousand 35- and 40-foot containers and had an in-port turnaround time of 24 hours. To enhance their military sealift capability, the Navy had the ships converted to a combination RORO/container configuration. This process included installing decks midship for RORO, adding a flight deck for helicopter operations, and retaining existing container cells. The converted SL-7 capabilities included both LOLO and RORO operations and rapid transport of military vehicles and equipment, including tanks and helicopters. Originally designated T-AKRs and identified as MSC RORO vessels, these ships have since been designated as FSSs.

The FSS transports, loads, and off-loads its cargo without nonorganic MHE. Although the vessel is largely self-sustaining, it requires longshoremen, vehicle drivers, and aircraft handlers to perform cargo operations. FSS characteristics include a draft of 34.5 feet, a speed of 27 knots, and a range of 12,200 nautical miles. It has 185,000 square feet of stowage and can transport 1,100 HMMWVs. FSS missions include:

- Rapid deployment of equipment and supplies of heavy combat units to locations around the globe.
- Rapid reinforcement of NATO and other commands worldwide.
- Rapid resupply/sustainment of deployed forces.

See Figure 5-25, for an illustration of an FSS.

Break-bulk ships. Break-bulk vessels fall under the category of general cargo (boxed, palletized, refrigerated, and limited containerized). Cargo operations on a break-bulk ship consist of LOLO operations. Each hold on the ship is serviced by ship's gear, booms, cranes, and winches. These vessels are considered to be self sustaining. They are labor-intensive and not the preferred method for moving tracked and wheeled vehicles.

Container ships. Container ships are designed to carry their entire cargo load in containers (usually 20- or 40-foot). The full cellular stowage within their holds allows containers to be secured without using dunnage. Container ships are configured for the stacked stowage of containers, both in the space below the main deck and on the main deck. Most of these vessels are non-self-sustaining and require the use of shoreside cranes or T-ACS.

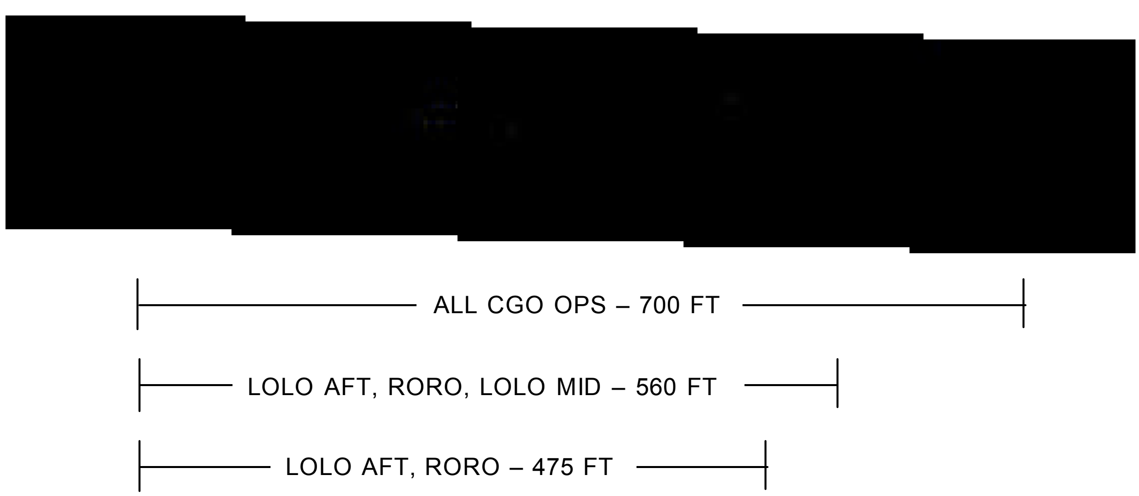


Figure 5-25. Fast sealift ship

Barge carriers. Barge carriers transport barges on which cargo has been loaded. These barges are loaded or discharged at berths by shore-based cranes. When cargo operations are complete, the barges are pushed or towed to the barge carrier and brought aboard. The LASH and the SEABEE are the two types of barge carriers used by the Army.

RORO ships. RORO ships are designed primarily to transport vehicles. Their cargo includes helicopters and wheeled, tracked, self-propelled and towed vehicles. RORO vessels are characterized by large cargo capacities and rapid cargo loading and discharge rates. The rapid movement of cargo is accomplished by a series of external and internal ramps. The cargo holds are typically large, open bays where equipment is driven into, parked, and lashed down. Most RORO ships have external stern ramps that rest on the apron of the berth, allowing access to the cargo holds. For this reason, RORO ships are considered to be self-sustaining. The RORO ship is considered ideally suited for the movement of unit equipment.

Large medium speed RORO. The LMSR (Figure 5-26) is a new class of strategic sealift ship designed to upgrade lift capability and expand the Army's prepositioned afloat program. In 1992, the Mobility Requirements Study identified a shortfall of 3 million square feet of surge capability and 2 million square feet of prepositioned sealift capability. To satisfy this shortfall, 19 LMSRs are either being built or converted. The first ship was scheduled for delivery in FY 96. The LMSRs are MSC-owned and will be operated under commercial contract.

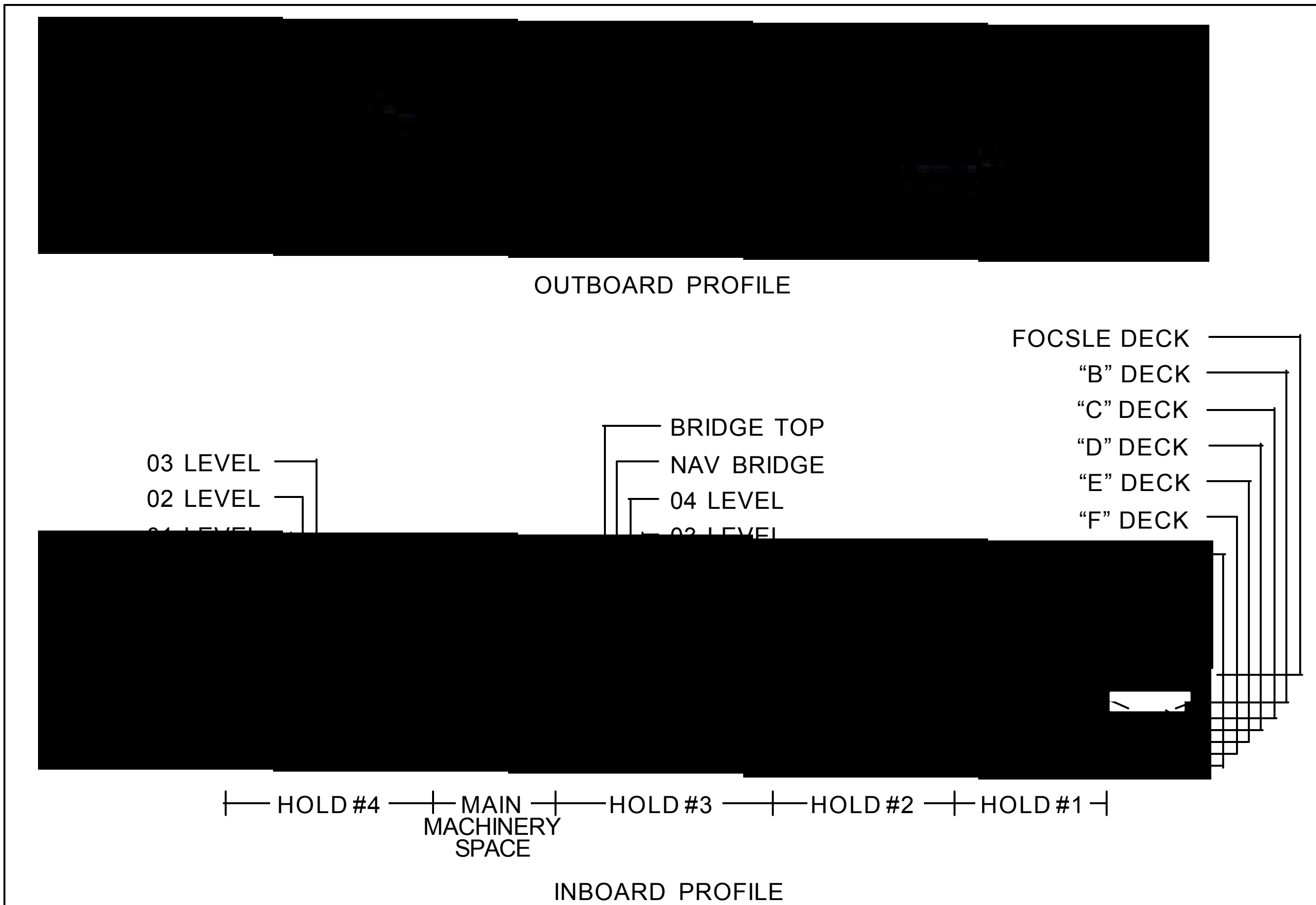


Figure 5-26. Large medium speed RORO

Along with FSSs, the LMSR will enable the Army to surge two heavy divisions to any theater in 30 days and then return to pick up follow-on forces. LMSRs have 380,000 square feet of stowage and can transport 1,998 HMMWVs. They have a speed of 24 knots. Other features include a slewing stern ramp, a side ramp, twin cranes, and an emergency heliport. The ship's draft is 35 feet. Eight of the 19 LMSRs are scheduled to replace RORO ships in the AWR-3 program.

Auxiliary crane ship. The T-ACS (Figure 5-27) is a converted container ship from the MARAD Reserve Force. It has been modified by the installation of twin booms, marine heavy-lift cranes used to off-load non-self-sustaining ships. The T-ACS can discharge its own cargo. It can also discharge another vessel in areas where port facilities are inadequate or nonexistent.

US ARMY WATERCRAFT FLEET

While strategic sealift delivers over 95 percent of the tonnage required by operating military forces, Army watercraft become the critical link when that tonnage is projected over the shore, through fixed ports not accessible to deep-draft vessels, or through fixed ports not adequate without the use of watercraft (all classified as LOTS operations). Army watercraft units execute all functions required for successful theater opening, reception, and sustainment of the deployed force.

A proper mix of Army watercraft must be prepositioned for availability during the early phases of force closure. Army watercraft can be prepositioned on FLOFLO ships, SEABEEs, and/or on the decks of other large vessels.

Vessel Designations

Each vessel in the Army's marine fleet bears an individual serial number, preceded by an applicable prefix. Vessel prefixes are as follows:

- Barge, dry-cargo, 1 nonpropelled, medium (100 through 149 feet) – BC
- Conversion kit, barge deck enclosure – BCDK
- Barge, dry-cargo nonpropelled, large (160 feet and over) – BCL
- Crane, floating – BD
- Lighter, beach discharge – BDL
- Barge, liquid cargo, nonpropelled – BG
- Barge, dry cargo, nonpropelled – BK
- Barge, pier, nonpropelled – BPL
- Barge, refrigerated, nonpropelled – BR
- Ferryboat – FB
- Dry dock, floating – FD
- Repair shop, floating, marine craft, nonpropelled – FMS
- Freight and supply vessel large (140 feet and over) – FS
- Boat, utility – J
- Lighter, amphibious – LARC
- Landing craft, mechanized – LCM
- Landing craft, utility – LCU
- Logistics support vessel – LSV
- Tug, large, seagoing – LT
- Tug, small, harbor – ST
- Boat, passenger and cargo – T
- Temporary crane discharge facility – TCDF
- Vessel, liquid cargo – Y

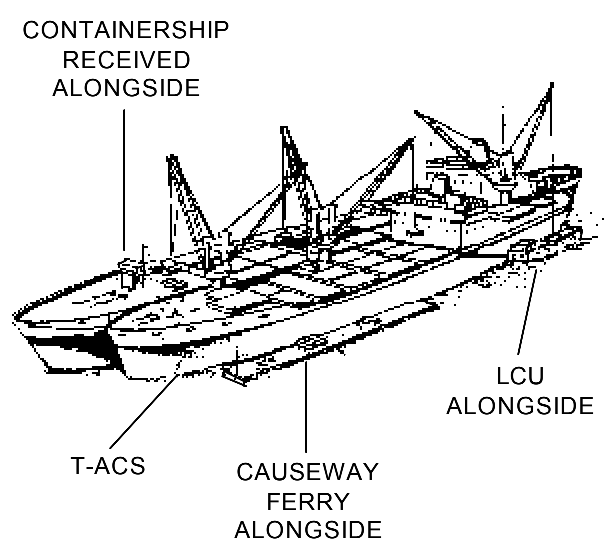


Figure 5-27. Auxiliary crane ship in operation

Traditional Army Watercraft

This section contains information on various Army vessels, including mission, transportability, and characteristics and capabilities. See Figure 5-28, page 5-44, for illustrations of the water craft discussed in the following paragraphs.

Landing craft mechanized-8. The LCM-8 transports cargo, troops, and vehicles from ship to shore or in retrograde movements. It is also used in lighter and utility work in harbors. The LCM-8 is designed for use in rough or exposed waters and can be operated through breakers and grounded on the beach. The bow ramp allows RORO operations with wheeled and tracked vehicles. Its small size allows for use in confined areas.

The LCM-8 can be transported by LSVs, LCU 2000s, LSTs, commercial bulk carriers, and heavy lift ships. Characteristics and capabilities include the following:

- Length overall: 74 feet.
- Beam: 21 feet.
- Displacement (weight): 58 LTONs (light); 111 LTONs (loaded).
- Deck area: 620 square feet.
- Payload: 53 tons.
- Range: 332 nautical miles at 11 knots (light); 271 nautical miles at 9 knots (loaded).
- Draft: 3.5 feet (light); 5 feet (loaded).

Lighter, amphibious, resupply, cargo, 60-ton. The LARC-60 transports wheeled and tracked vehicles, including beach preparation equipment and general cargo from ship to shore or to inland transfer points. It is the only amphibian in the Army inventory, and the only vessel capable of landing on a beach through a breaking surf. The LARC-60 can be deck-loaded on a commercial vessel or heavy lift ship for transport overseas. It can be transported on a semi-submersible vessel, in the well deck of an LSD, or aboard a SEABEE. Characteristics and capabilities include the following:

- Length overall: 63 feet.
- Beam: 27 feet.
- Displacement (weight): 88 LTONs (light).
- Deck area: 527 square feet.
- Payload: 60 tons.
- Range: land, 60-ton load, 150 statue miles at 14 MPH; water, 60-ton load, 75 nautical miles at 6 knots.
- Draft: 7.5 feet (light); 9 feet (loaded).

Landing craft, utility, 1600 class. The LCU-1600 transports wheeled and tracked equipment and general cargo from ship to shore, shore to shore, and in retrograde operations. RORO missions are accomplished using the vessel's bow and stern ramps. It is valuable in LOTS operations and intratheater transport using harbor and IWW routes. The LCU-1600 is not capable of self-deployment over open oceans. It is deployed aboard vessels such as HLPSs, barges, and FLOFLO ships. It can also be loaded on Navy LSTs, LSDs, or commercial bulk carriers. Characteristics and capabilities include:

- Length overall: 135 feet.
- Beam: 30 feet.
- Displacement (weight): 205 LTONs (light); 390 LTONs (loaded).
- Deck area: 1,785 square feet.
- Payload: 184 tons.
- Range: 1,200 nautical miles at 12 knots (light); 1,100 nautical miles at 11 knots (loaded).
- Draft: 6 feet (light); 7 feet (loaded).

Small tug, 65-foot. The 65-foot tug moves non-propelled barges in harbors and IWWs. Secondary functions include general utility uses, fire fighting, salvage, and assisting in the docking and undocking of large vessels. Overseas deployment is by deck loading aboard a heavy lift ship or by towing by a larger vessel. Characteristics and capabilities include:

- Length overall: 71 feet.
- Beam: 19.5 feet.
- Displacement (weight): 100 LTONs (light); 122 LTONs (loaded).
- Bollard pull: 8.75 tons.
- Range: 1,700 nautical miles at 12 knots (light); variable with tow (loaded).
- Draft: 7.5 feet (light); 8.5 feet (loaded).

Large tug, 100-foot. The 100-foot tug is used to berth and unberth large oceangoing vessels and for heavy towing within harbor areas. Secondary functions include general utility uses, fire fighting, and salvage operations. It may also be used for limited off-shore towing between terminals. Depending upon distance, weather, sea conditions, and crew training, the 100-foot tug can self-deploy or be transported by FLOFLO. Characteristics and capabilities include:

- Length overall: 107 feet.
- Beam: 27 feet.
- Displacement (weight): 295 LTONs (light); 390 LTONs (loaded).
- Bollard pull: 13.8 LTONs/31.5 LTONs.
- Range: 3,323 nautical miles at 12.8 knots/ 2,245 nautical miles at 12.8 knots (light); variable with tow (loaded). NOTE: Higher fuel consumption of larger engines in ESP tugs reduces range.
- Draft: 11.5 feet (light); 12.5 feet (loaded).

Floating machine shop. The FMS consists of 14 repair shops, an onboard 9-LTON crane, and an internal monorail trolley system. The shops are battery, blacksmith, carpentry, electrical, engine, fuel injection, machine, sheet metal, paint, pipe fitting, radar and radio, refrigeration, shop fitting, and welding. The FMS can accomplish DS/GS level maintenance, repair, rebuild, and overhaul. The FMS can support the sustainment phase of operations. It is not self-propelled; therefore, it must be towed to overseas locations. Characteristics and capabilities of the FMS include:

- Length overall: 210 feet.
- Beam: 40 feet.
- Displacement (weight): 1,160 LTONs (light); 1,525 LTONs (loaded).
- Draft: 6 feet (light); 8 feet (loaded).

Crane, barge, 89-ton. The BD 89T is used to load and discharge heavy lift cargo that is beyond the capacity of ship’s gear. It is commonly called the 100-ton crane which is the short ton capacity rating. The BD 89T is not self-propelled; it can be towed overseas or deck-loaded aboard a semi-submersible ship for transport. Its characteristics and capabilities include:

- Length overall: 140 feet.
- Beam: 70 feet.
- Displacement (weight): 1,630 (loaded).
- Boom length: 123.5 feet.
- Capacity: 89 LTONs at 80-foot radius.
- Draft: 6.3 feet (loaded).

Barge, deck or liquid cargo, BG 231C (fuel). The BG 231 transports liquid or general cargo in harbors and inland waters. It can transfer liquid products from off-shore tankers to shore facilities. The BG 231 can also serve as a refueling point for watercraft operating in the area. The barge is equipped with two skegs aft; this improves its towing capability by helping to keep it tracking on course. It can be towed overseas or deck-loaded aboard an HLPS. Characteristics and capabilities include:

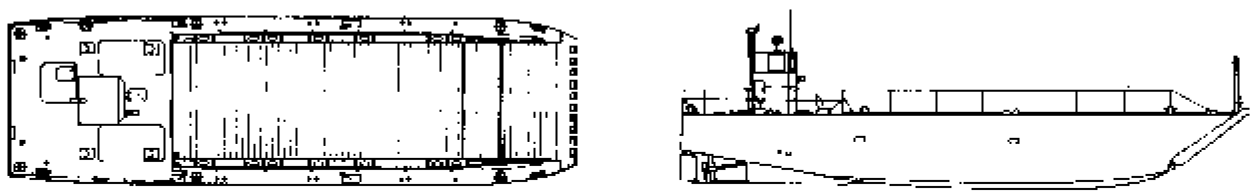
- Length overall: 120 feet.
- Beam: 33 feet.
- Displacement (weight): 185 LTONs (light); 763 LTONs (loaded).
- Cargo capacity: deck, 578 LTONs; liquid, 4,160 barrels (188,416 gallons).
- Cargo pump capacity: 1,050 gallons per minute.
- Draft: 3 feet (light); 9 feet (loaded).

Barge, deck cargo, BC 231A. The BC 231 transports containers, general cargo, and wheeled and tracked vehicles in harbors and IWWs. It is particularly suited for transporting tracked and wheeled vehicles. It is equipped with two skegs aft, thereby improving its towing capability by helping to keep it tracking on course. The BC 231 can be loaded aboard ships or towed overseas. Characteristics and capabilities include:

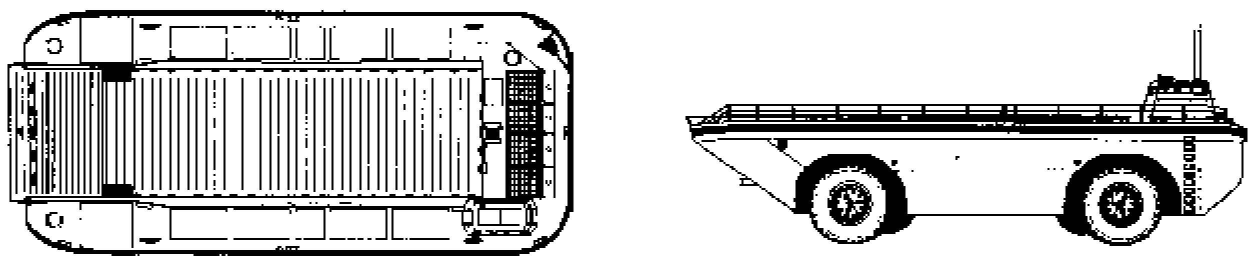
- Length overall: 120 feet.
- Beam: 33 feet
- Displacement (weight): 175 LTONs (light); 760 LTONs (loaded).
- Cargo capacity: 585 LTONs.
- Draft: 2.5 feet (light); 8 feet (loaded).

Barge, deck cargo, BC 7005. The BC 7005 transports containers, general cargo, and wheeled and tracked vehicles in harbors and IWWs. Because of its flush deck without fore and aft sheer, it is particularly suited for transporting vehicles. The BC 7005 was built without skegs, making it easy to maneuver at port terminals where piers are in close proximity. The BC 7005 can be deck-loaded aboard ships or towed overseas. Characteristics and capabilities include:

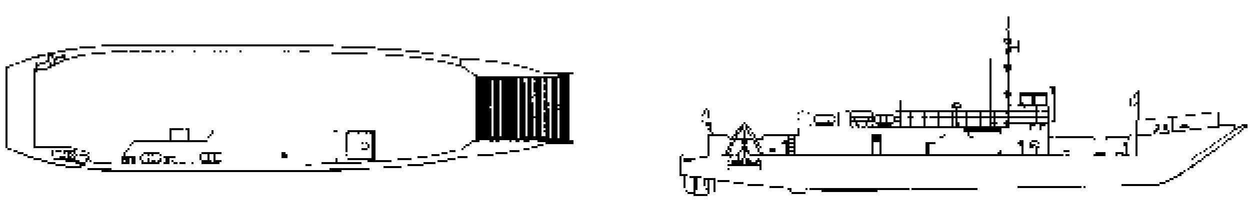
- Length overall: 110 feet.
- Beam: 32 feet.
- Displacement (weight): 120 LTONs (light); 690 LTONs (loaded).
- Cargo capacity: 570 LTONs.
- Draft: 1.75 feet (light); 7.5 feet (loaded).



LANDING CRAFT, MECHANIZED, LCM-8

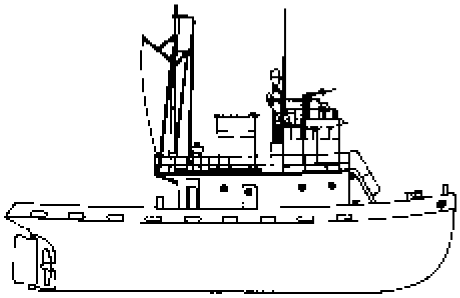


LIGHTER, AMPHIBIOUS, RESUPPLY, CARGO, 60 TON, LARC-60

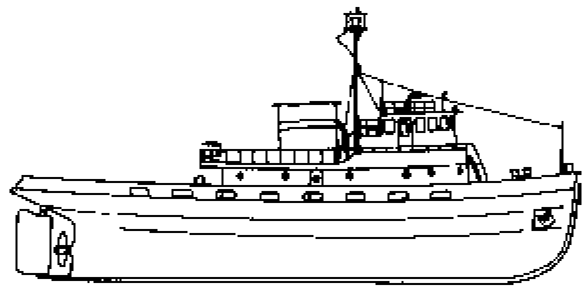


LANDING CRAFT, UTILITY, 1600 CLASS

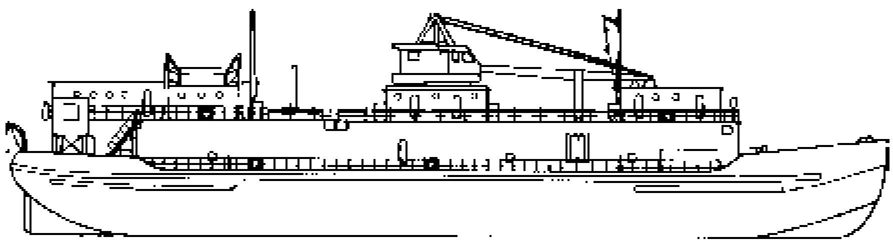
Figure 5-28. Army watercraft



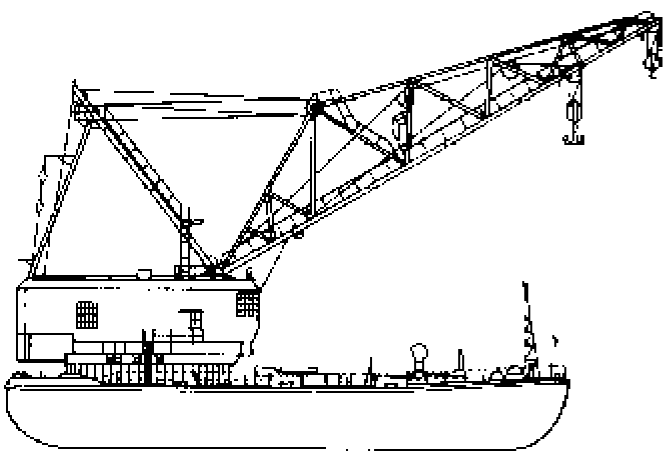
TUG, HARBOR, 65-FOOT, DESIGN 3004



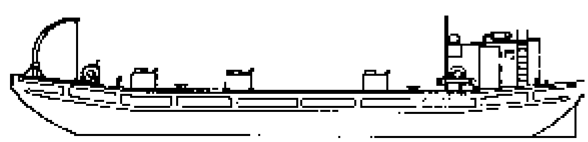
TUG, HARBOR, 100-FOOT, DESIGN 3006



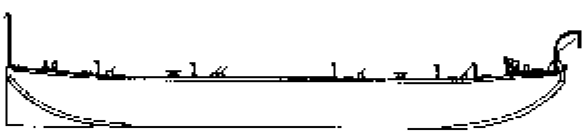
FLOATING MACHINE SHOP, DESIGN 7011



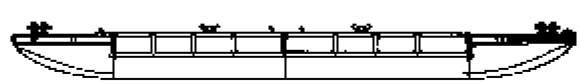
CRANE, BARGE, 89-TON



BARGE, DECK OR LIQUID CARGO,
BG 231C (FUEL)



BARGE, DECK CARGO, BC 231A



BARGE, DECK CARGO, BC 7005

Figure 5-28. Army watercraft (continued)

Fleet Modernization

Recent watercraft modernization efforts have significantly enhanced the Army's capability to project and sustain America's military force. The following watercraft are representative of the modern Army fleet.

Landing craft, utility 2000. The LCU 2000 (Figure 5-29, page 5-47) transports rolling and tracked vehicles, containers, and outsized and general cargo from ships offshore to shore (LOTS), as well as to areas that cannot be reached by oceangoing vessels (coastal, harbor, and IWWs). It can be self-deployed or transported aboard a FLOFLO vessel. It is classed by the ABS for full ocean service and one-man engine room operations and is built to USCG standards. The LCU 2000 succeeds the 1646 Class LCU and replaces the 1466 Class in both the Army's Active and Reserve inventories. The Army has 35 LCU 2000s. Characteristics and capabilities of the LCU 2000 include:

- Length (overall): 174 feet.
- Beam: 42 feet.
- Displacement: 575 LTONs (light); 1,087 LTONs (loaded).
- Deck area: 2,500 square feet (5 M1 main battle tanks or 12 [24 double-stacked] 20-foot ISO containers.
- Bow ramp: 16 feet wide x 22 feet long.
- Payload: 350 STONs (15 C-141 loads).
- Range: 10,000 nautical miles at 12 knots (light); 6,500 nautical miles at 10 knots (loaded).
- Draft: 8 feet (light); 9 feet (loaded).
- Beaching draft: 4 feet at the bow.
- Carries up to thirty 20-foot containers or twelve 40-foot containers.
- Sustains crew of 2 warrant officers and 11 enlisted personnel for up to 18 days.
- Equipped with latest navigation, communications, and electronic equipment including an automatic pilot and steering system.

Logistics support vessel. The LSV (Figure 5-30, page 5-47) provides worldwide transport of general and vehicular cargo. LSV missions include intratheater line-haul in support of unit deployment or relocation; tactical and sustained resupply to remote, undeveloped areas along coastlines and on IWWs; and support to the discharge and backload of ships in RORO or LOTS operations. Six LSVs are in the Army inventory. LSV characteristics and capabilities include:

- Length (overall): 273 feet.
- Beam (molded): 60 feet.
- Displacement (weight): 4,199 LTONs.
- Deck area: 10,500 square feet (21 to 24 M1 main battle tanks or 25 [50 double-stacked] 20-foot ISO containers).
- Bow ramp opening: 26 feet wide.
- Payload: 2,000 STONs (86 C-141 loads).
- Range: 8,200 nautical miles at 12.5 knots (light); 6,500 nautical miles at 11.5 knots (loaded).
- Draft: 6 feet (light); 12 feet (loaded).
- Drive-through capability (bow and stem ramps).
- Self-delivery range: 6,500 nautical miles.
- Sustains crew of 6 officers and 23 enlisted personnel for up to 30 days.
- Transports heavy, outsized cargo including rolling stock, general cargo, and ISO containers.

Large tug, 128-foot. The 128-foot LT (Figure 5-31, page 5-48) is designed for ocean and coastal towing operations. All six LTs were fielded in 1994. LT missions include: assisting bulk and special cargo ships to berth or anchorage; shuttling non-self propelled barges and other floating equipment from location to location during LOTS operations; and providing ocean, coastal, and inland waterway tow service for Army logistic support. The LT is self-deployable worldwide. Characteristics and capabilities include:

- Length overall: 128 feet.
- Beam (molded): 36 feet.
- Displacement (weight): 786 LTONs (light); 1,057 LTONs (loaded).
- Bollard pull: 58 tons.
- Range: 5,000 nautical miles at 13.5 knots (light); 5,000 nautical miles at 12 knots (loaded).
- Draft: 14.5 feet (light); 17 feet (loaded).

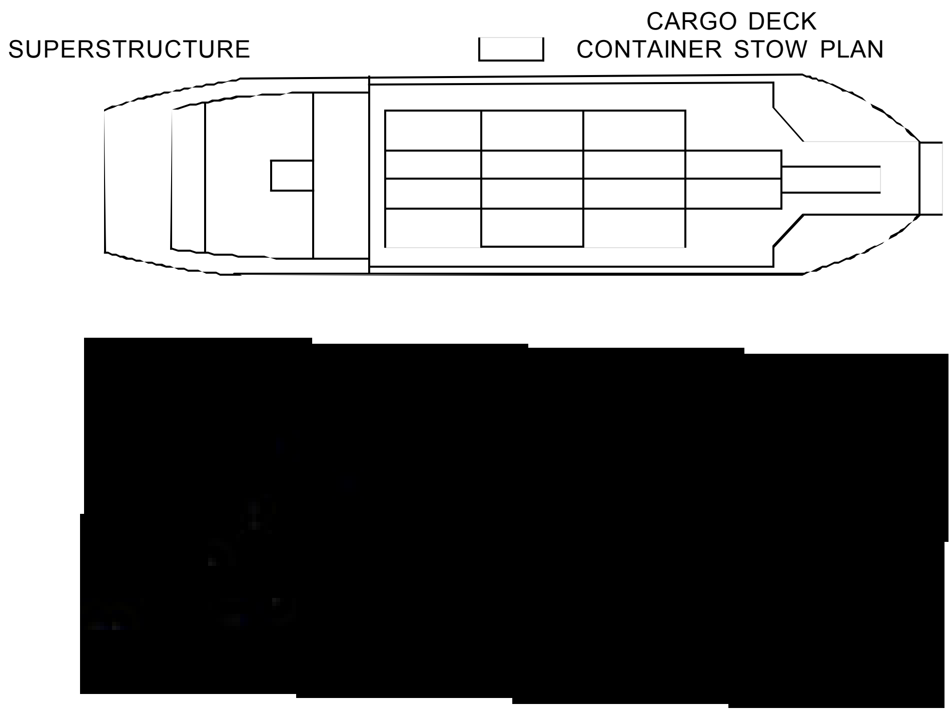


Figure 5-29. Landing craft, utility, 2000 class

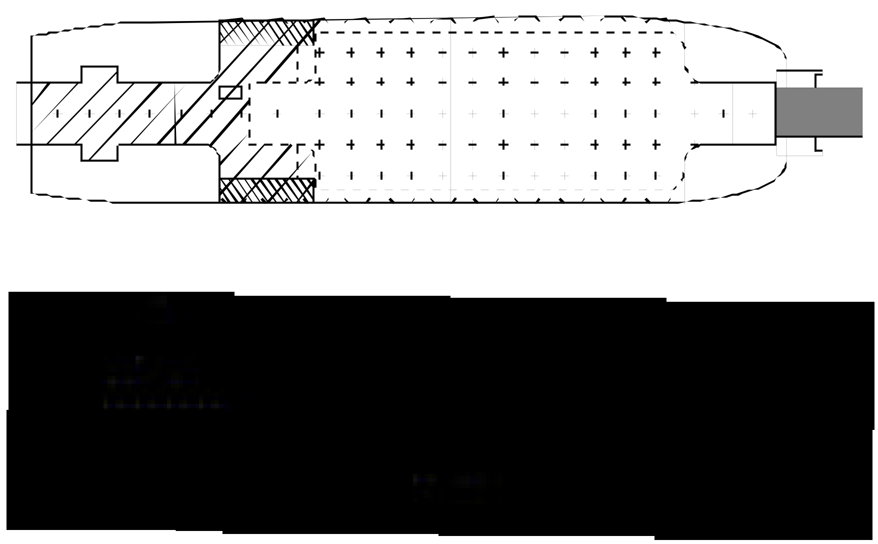


Figure 5-30. Logistics support vessel

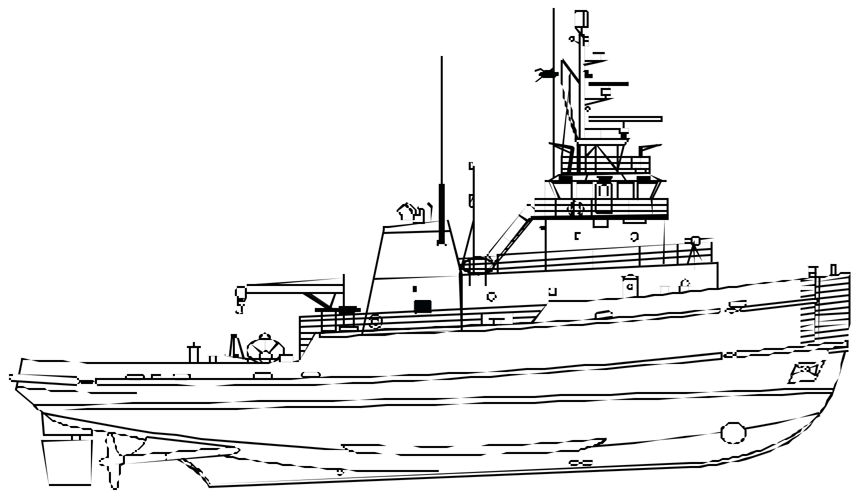


Figure 5-31. Large tug

Modular causeway system (causeway ferry). The CF consists of a powered section, made up of powered modules with internal propulsion and control components connected to the non-powered modules; two non-powered intermediate sections; and a non-powered combination beach/sea end section joined end-to-end. Characteristics and capabilities of the CF include:

- Loaded capacity of 100 STONs per non-powered section; approximately 50 STONs for the powered section.
- Total cargo capacity of 350 STONs with about 12 inches of freeboard.
- State-of-the-art equipment for pilot-to-operator, operator-to-commercial ship, and operator-to-command and control communications.
- Deployable aboard container ships and other cargo vessels.

Upon arrival in the operational area, CF components will be off-loaded and assembled for use. The CF is used to move rolling, break-bulk, and containerized cargo from oceangoing vessels directly to the shore-side logistic operation or to a fixed or semi-permanent pier. Also, it can operate in the JLOTS environment supporting RORO and LOLO operations.

RORO discharge facility. The RRDF (Figures 5-32 and 5-33, page 5-49) provides interface between Army lighters and RORO ships. It supports both self-sustaining and non-self-sustaining RORO ships. The RRDF has the following components:

- RORO platform – about 65 feet wide by 180 feet long.
- "B" or Sea End section with provisions for "Rhino" horn – provides interface between the RORO platform and displacement craft.
- CWR – used with non-self-sustaining ships.
- Fendering system – used with non-self-sustaining ships.
- Lighting system – used during generation and distribution.
- Emergency anchoring system – used when the ship being serviced is required to depart due to enemy actions or adverse weather conditions.

The RRDF is tendered by two SLWTs (Figure 5-34, page 5-50). The SLWT is an ASIOE for the RRDF. The SLWT has a deck-mounted A-frame and winch for hoisting/lifting and assembly of the RRDF hardware and components. The SLWT also has a stern anchor.

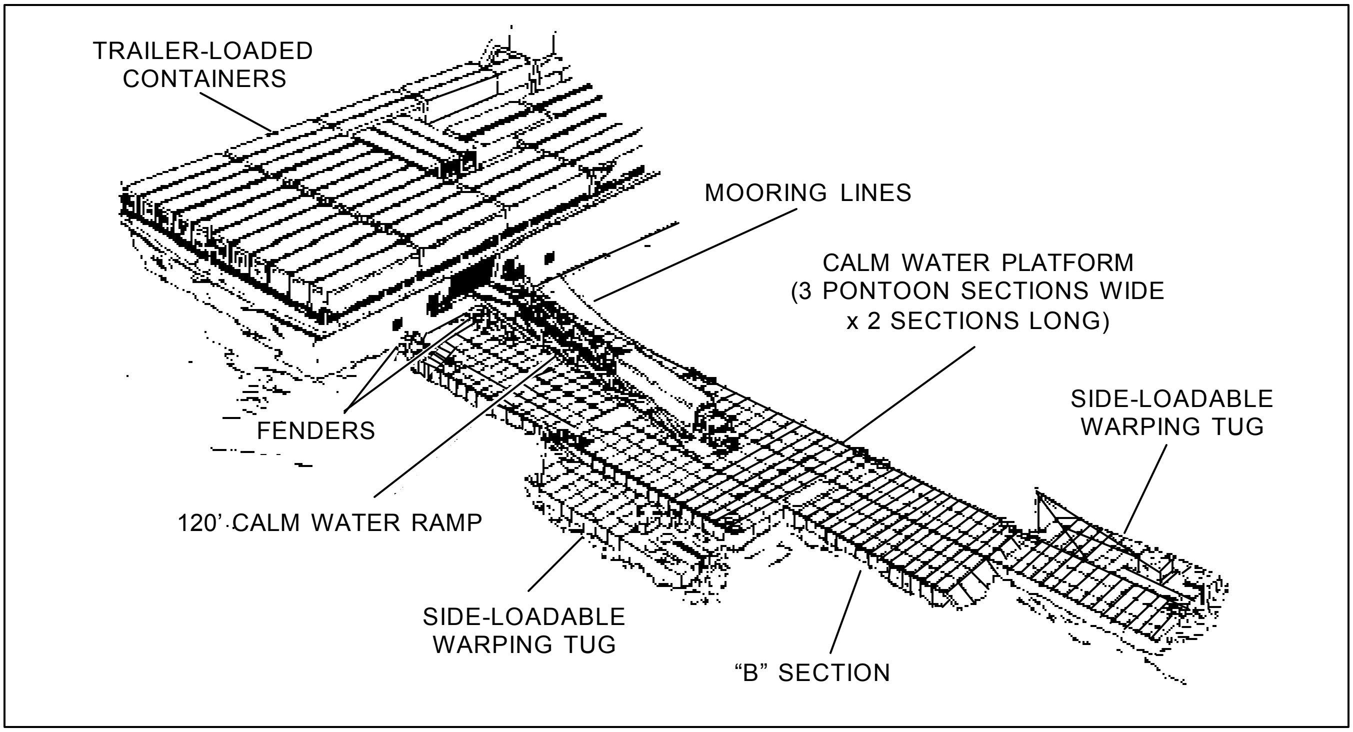


Figure 5-32. RORO discharge facility with ramp at side port

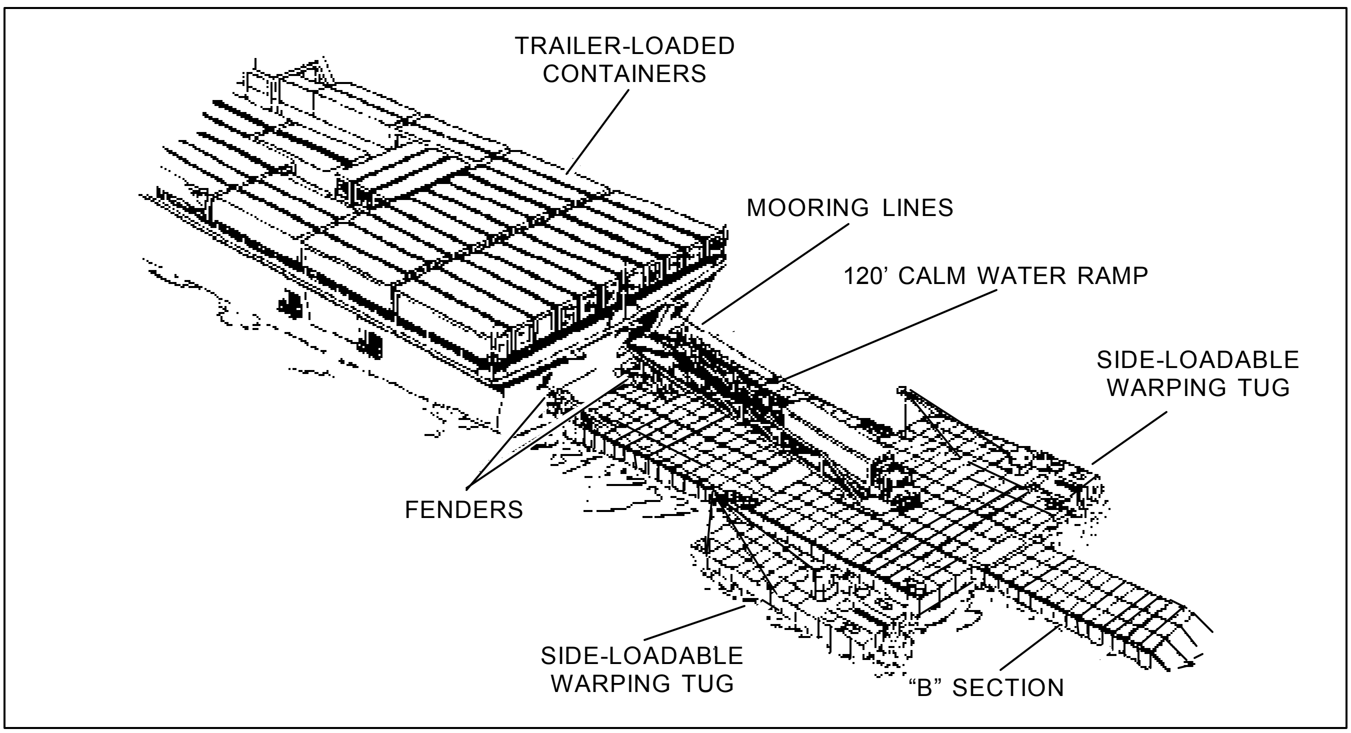


Figure 5-33. RORO discharge facility with ramp at stern port

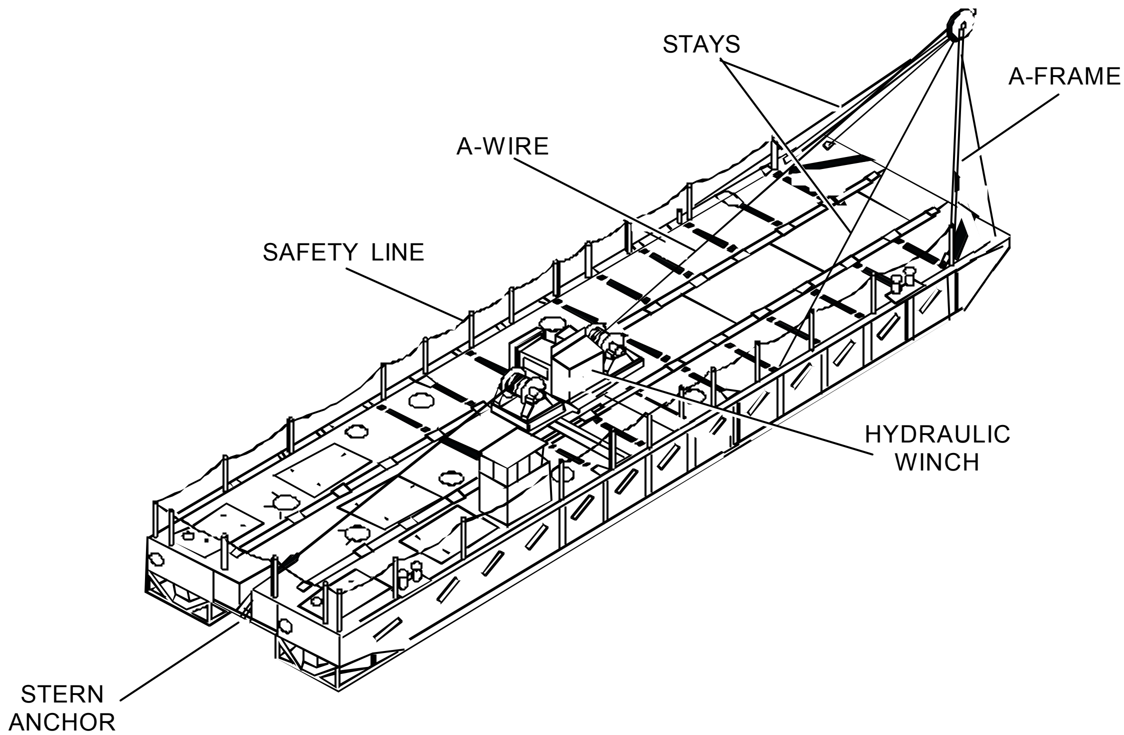


Figure 5-34. Side loadable warping tug, operational configuration

Modular causeway system (floating causeway). The FC provides a dry bridge for the transfer of cargo (primarily rolling cargo) from displacement lighters to the shoreside logistic operations. It includes the following components:

- 17 non-powered intermediate modular cause-way sections.
- 2 combination beach and sea-end sections.
- Anchor mooring system – the AMS is used to retain an in-place FC. Employs large marine anchors placed perpendicular to the roadway, offshore, and dry beach anchors to secure the FC to the beach.
- 2 SLWTs.

Characteristics and capabilities of the FC are as follows:

- Extends from the high water line out into the surf zone to a mean low water depth of 8 feet.
- Has maximum working length of approximately 1,500 feet.
- Offshore end incorporates an adapter end for the discharge of cargo from displacement lighters onto the roadway.
- Offshore end uses the “Rhino” horn to mate with lighters, so equipped.
- Two SLWTs are ASIOE. The SLWTs are used to insert, retract, and tender the FC and to in-place and remove AMS anchors.

The Army’s watercraft modernization program charts the course for continuous fleet moderniza-tion through 2011. Modernization efforts encompass the following: on-condition cyclic maintenance, material change, extended service program, research and development, and procurement.

APPENDIX A
TABLES OF ORGANIZATION AND EQUIPMENT

This appendix contains a detailed breakdown of transportation and transportation-related units by TOE, mission, assignment, and capabilities.

COMMAND AND CONTROL

TOE 55500LB
Detachment LB
Platoon Headquarters, Separate

Mission. Commands, controls, and supervises a transportation platoon.

Assignment. Normally assigned to a transportation company.

Capabilities. Commands and controls a platoon normally composed of more than one detachment with an aggregate strength of not less than 40 soldiers and that does not have an organic commissioned officer.

TOE 55500LC
Detachment LC
Company Headquarters

Mission. Commands, controls, and supervises a transportation company.

Assignment. Normally assigned to a transportation battalion or group or may operate separately.

Capabilities. Provides command, control, and unit administration for the equivalent of two or more platoons with a company strength of not less than 80 soldiers.

TOE 55500LD
Detachment LD
Battalion Headquarters

Mission. Commands, controls, and supervises a transportation battalion.

Assignment. Normally assigned or attached to transportation group or brigade or may operate separately.

Capabilities. Commands and controls three to seven transportation companies and/or combinations of service companies, or detachments of equivalent size.

TOE 55601L0
Headquarters and Headquarters Company
Transportation Command

Mission.

- Commands, controls, and provides technical supervision of assigned/attached units supporting the TA with all modes of transportation and related services including DS/GS maintenance for rail and Army watercraft.
- Provides staff assistance to the TA DCSLOG for theater level transportation plans, policies, and procedures; information on transportation capacity

and capability to the TMCA; liaison with other US and allied forces and control of designated wartime HN support resources.

Assignment. To a TA.

Capabilities.

- Commands and supervises the activities of all transportation headquarters and other assigned or attached units operating and/or supporting the transportation services required to support the TA.
- Provides staff planning and coordination of transportation CSS activities as assigned by the TA DCSLOG.
- Controls, through its subordinate headquarters, the HN resources allocated to the TA transportation service.

TOE 55622L0
Headquarters and Headquarters Company
Transportation Composite Group

Mission. Commands and controls units that provide transportation services for an independent division-size force, or for a two-division separate corps force, or that provide transportation services on an area basis supporting a larger force.

Assignment. To the headquarters commanding an independent division-size force; to the corps, with attachment to the corps support command, when supporting a two-division separate corps force; or to a TA, with attachment to a transportation command, when supporting a larger force.

Capabilities.

- Commands, controls, and technically supervises three to seven battalions and their assigned/attached units.
- Develops and supervises implementation of programs, plans, and policies for employment of attached units and contract/wartime HN agencies/units providing transportation support.
- Provides a nucleus organization during the early stages of the buildup of an immature theater for the development of a transportation brigade or transportation command as the theater matures.
- Performs relational data base management and table maintenance for the regional segment of the WPS.
- Provides technical supervision of WPS operations throughout the composite group's operational area.

MOVEMENT CONTROL

All teams from TOE 55580L will be replaced by detachments from TOE 55606L.

TOE 55580LA
Team LA
Movement Control

Mission. Performs movement control functions for movement of personnel and materiel (except bulk POL by pipeline).

Assignment. To a TA area command or a corps support command. Normally attached to a transportation MCA or transportation MCC.

Basis of allocation. As required, based on the stated capabilities.

Capabilities. Provides single shift movement control functions at intermediate transfer points, small Army air terminals, or specialized supply installations. May also be used to augment a larger MCT when the size of the operation warrants.

TOE 55580LB
Team LB
Movement Control

Mission. Performs movement control functions for movement of personnel and materiel (except bulk POL by pipeline).

Assignment. To a TA area command or a corps support command. Normally attached to a transportation MCA or transportation MCC.

Basis of allocation. As required, based on the stated capabilities.

Capabilities. Provides single shift movement control functions at a two-ship LOTS terminal, a one- or two-ship fixed water terminal, or an inland transfer point.

TOE 55580LC
Team LC
Movement Control

Mission. Performs movement control functions for movement of personnel and materiel (except bulk POL by pipeline).

Assignment. To a TA area command or a corps support command. Normally attached to a transportation MCA or a transportation MCC.

Basis of allocation. As required, based on the stated capabilities.

Capabilities. Provides single shift movement control functions supporting general support supply and/or maintenance activities, or for a four-ship fixed water terminal operation or a rail or motor terminal.

TOE 55580LD
Team LD
Movement Control (Region)

Mission. Performs movement control functions for movement of personnel and materiel (except bulk POL by pipeline).

Assignment. To a TA area command or a corps support command. Normally attached to a transportation MCA or a transportation MCC.

Basis of allocation. As required, based on the stated capabilities.

Capabilities. Coordinates the activities of up to ten subordinate MCTs on a 24-hour basis; may be employed as a central movement control element supporting a tactical force where employment of transportation MCC is not warranted.

TOE 55580LE
Team LE
Movement Control (Region)

Mission. Performs movement control functions for movement of personnel and materiel (except bulk POL by pipeline).

Assignment. To a TA area command or a corps support command. Normally attached to a transportation MCA or transportation MCC.

Basis of allocation. As required, based on the stated capabilities.

Capabilities. Coordinates the activities of up to ten subordinate MCTs on a single-shift basis, provides a central movement element supporting a small tactical force where employment of transportation MCT logistics doctrine is not warranted.

TOE 55580LF
Team LF
Movement Control (Air Terminal)

Mission.

- Coordinates the expeditious clearance of Army cargo and personnel from USAF air terminals.
- Coordinates the arrival of retrograde or resupply cargo and personnel.

Assignment. To a TA area command or a corps support command. Normally attached to a transportation MCA or transportation MCC.

Basis of allocation. One per USAF air terminal; requires coordination of movements of Army cargo and personnel IAW stated capabilities.

Capabilities. Performs the following movement control functions on a 24-hour basis.

- Expedites the clearance of Army cargo and personnel arriving at a USAF terminal.
- Coordinates local movement of retrograde or resupply cargo and personnel.
- Provides technical expertise in the functional areas of transportation, medical services, adjutant general, and supply to coordinate with functional counterparts in the TA area command and/or corps support command.
- Provides liaison with the USAF air terminal commander on matters associated with the clearance of Army cargo and personnel, the local movement of retrograde or resupply cargo and personnel, and as required for deployment movement of Army tactical forces.

TOE 55580LG
Team LG
Movement Control (Air Terminal)

Mission.

• Coordinates the expeditious clearance of Army cargo and personnel from USAF air terminals.

• Coordinates the arrival of retrograde or resupply cargo and personnel.

Assignment. To a support command. Normally attached to a transportation MCA or transportation MCC.

Basis of allocation. One per USAF air terminal; requires coordination of movements of Army cargo and personnel IAW stated capabilities.

Capabilities. Performs the following movement control functions on a 12-hour shift:

• Expedites the clearance of Army cargo and personnel arriving by USAF aircraft.

• Coordinates local movement of retrograde or resupply cargo and personnel.

• Provides technical expertise in the functional areas of transportation, medical services, adjutant general, and supply to coordinates with functional counterparts in the TA area command and/or corps support command.

• Provides liaison with the USAF air terminal commander on matters associated with clearing Army cargo and personnel and coordinating local movement of retrograde or resupply cargo and personnel as required for deployment movement of Army tactical forces.

TOE 55580LH
Team LH
Highway Regulation Point Team

Mission. Operates an HRP, coordinates the movement of authorized traffic, and makes changes to truck or convoy routings.

Assignment. To a TA area command or a corps support command. Normally attached to a transportation MCA or transportation MCC.

Basis of allocation. Normally one team for each major point of access or departure along a route over which highway regulation is exercised, and at other points where traffic may conflict or become congested.

Capabilities. Observes, follows, and reports progress of vehicles along routes and adjusts movement schedules as necessary on a single shift basis.

TOE 55603L0
Transportation Movement
Control Agency

Mission.

• Commands and supervises attached or assigned units and teams performing movement control and highway regulation.

• Provides movements management, highway regulation, and coordination, as required, for personnel and materiel movements into, within, and out of the TA.

Assignment. To a TA.

Capabilities. Commands and controls assigned or attached units or teams.

TOE 55604L0
Transportation Movement
Control Center
(Corps)

(Will be replaced by 55606L100.)

Mission. Commands and supervises attached or assigned units and teams engaged in movement control and highway regulation. Provides movement control for moving personnel and materiel (except bulk fuel by pipeline) within, into, or out of the area of responsibility, ensuring timely responsiveness and maximum use of available transport capability.

Assignment. To a corps.

Capabilities. On a 24-hour basis, this unit:

- Commands and controls assigned or attached units or teams.
- Provides a central organization and field office necessary to perform movement control and highway regulating services supporting a corps when augmented by movement control organizations of TOE 55580LXXX.
- Maintains liaison with transportation elements of other US forces and allied HN transportation agencies.

TOE 55606L100
HHD Transportation Movement Control Battalion (Corps)

Mission.

- Commands, controls, and supervises movement control detachments.
- Controls movement of personnel, units, and materiel (except bulk fuel by pipeline) into, within, and out of the area of responsibility and ensure effective and efficient use of available transport.

Assignment. To a corps.

Capabilities. On a round-the-clock basis, this unit:

- Commands, controls, and provides technical supervision of assigned or attached transportation movement control detachments.
- Plans, coordinates, and manages movement programming, highway regulation, and transportation support for the corps. When augmented by appropriate detachments, it provides a central headquarters to execute these missions, provide asset visibility, and maintain in-transit visibility of tactical and nontactical moves for the corps.

TOE 55606L200
HHD Transportation Movement Control Battalion (EAC)

Mission.

- Commands, controls, and supervises movement control detachments.
- Controls movement of personnel, units, and materiel (except bulk fuel by pipeline) into, within, and out of its area of responsibility and ensures effective and efficient use of available transport.

Assignment. To a TA, attached to a TMCA.

Capabilities. On a round-the-clock basis, this unit:

- Commands, controls, and provides technical supervision of assigned or attached transportation movement control detachments.
- Coordinates movement programming, highway regulation, and transportation support. When augmented by appropriate detachments, it provides a central headquarters to execute these missions and maintain in-transit visibility of tactical and nontactical moves within a geographical area of responsibility defined by the TMCA.

TOE 55606LA
Detachment LA
Port Movement Control Detachment

Mission. Expedites, coordinates, and supervises transportation support of units, cargo, and personnel into, through, and out of air or water ports.

Assignments. To a corps or a TA, attached to a transportation movement control battalion.

Capabilities. Within an air or water port area, this detachment performs the following movement control functions on a round-the-clock basis:

- Expedites the port clearance of cargo and personnel arriving or departing by air or sea.
- In conjunction with the port commander, coordinates transportation support and highway clearance for theater onward movement.
- Commits mode operators to transport personnel and materiel.

TOE 55606LB
Area Movement Control Detachment

Mission. Performs movement control functions for movement of units, cargo, and personnel (except bulk POL by pipeline) within an assigned geographic area.

Assignment. To a corps or TA, attached to a transportation movement control battalion.

Capabilities. Within its assigned geographic area of responsibility, this detachment performs the following movement control functions on a round-the-clock basis:

- Validates transportation requirements and coordinates transportation support, highway clearance, and inbound clearance for moving units, personnel, and cargo.
- Coordinates transportation movements, diversions, reconsignments, and transfers of units, cargo, and personnel.

TOE 55606LC
Division Support Movement Control Detachment

Mission. Augments the division movement control capability.

Assignment. To a corps, attached to a division.

Capabilities. Augments the DTO to perform movement control functions on a round-the-clock basis.

TOE 55606LD
Movement Regulating Detachment

Mission. Operates an MRP.

Assignment. To a corps or TA, attached to a transportation movement control battalion.

Capabilities. On a round-the-clock basis, this detachment observes, assesses, and reports progress of tactical and nontactical transportation movements along MSRs and adjusts movement schedules as necessary to coordinate the movement of authorized traffic, to implement changes in unit moves or vehicle/convoy routings, and to resolve movement conflicts. Provides first destination reporting points as required.

TOE 55606LE
Movement Control Cargo Documentation Detachment

Mission. Documents cargo transshipment in water, air, rail, and motor terminals.

Assignment. To a corps or a TA, attached to a transportation battalion movement control.

Capabilities. Performs documentation required for loading and discharging 500 STONs of general cargo or 480 containers daily in a water, rail, truck, or air terminal.

AIR TRANSPORT

TOE 01247A0
Medium Helicopter Company
Division Aviation Brigade
Air Assault Division
or
Medium Helicopter Company
Theater Aviation Battalion (Alaska)

Mission. Provides CH-47 aircraft (16) for the transport of personnel, supplies, and equipment supporting maneuver, CS, and CSS operations.

Assignment. Organic to a medium helicopter battalion or theater aviation battalion.

Basis of allocation. Three per medium helicopter battalion or one per theater aviation battalion.

Capabilities.

- Provides airlift for air assault operations.
- Transports tactical forces (other than assault), field artillery or other fire support assets, tactical air defense systems, engineer equipment and personnel, and other resources supporting CS operations.
- Moves general supplies, equipment, and personnel, including LOTS when applicable, for supporting CSS operations.

• Recovers disabled aircraft and other critical equipment, to include captured enemy equipment.

• Augments aeromedical evacuation when medical aircraft are inadequate or not readily available.

• Moves nuclear, chemical, and other special munitions.

• Evacuates noncombatants when directed by the applicable commander/authority.

• Self deploys all organic CH-47D helicopters to a theater of operations when the aircraft have been equipped for extended flight.

• Conducts continuous (day and night) operations during visual and marginal weather conditions and limited aviation operations during instrument weather conditions.

TOE 01447A0
Medium Helicopter Company
Corps Aviation Group
Corps Aviation Brigade
or
Medium Helicopter Company
Aviation Brigade, EAC

Mission. Transports personnel, supplies, and equipment supporting maneuver, CS, and CSS operations.

Assignment. Organic to a medium helicopter battalion.

Basis of allocation. Four per medium helicopter battalion or two per medium helicopter battalion.

Capabilities.

• Provides airlift for air assault operations.

• Moves tactical forces (other than assault), field artillery or other fire support assets, tactical air defense systems, engineer equipment and personnel, and other resources supporting CS operations.

• Moves general supplies, equipment, and personnel, including LOTS when applicable, supporting CSS operations.

• Recovers disabled aircraft and other critical equipment, to include captured enemy equipment.

• Augments aeromedical evacuation when medical aircraft are inadequate or not readily available.

• Moves nuclear, chemical, and other special munitions.

• Evacuates noncombatants when directed by the applicable commander/authority.

• Self deploys all organic CH-47D helicopters to a theater of operations when aircraft have been equipped for extended flight.

• Conducts continuous (day and night) operations during visual and marginal weather conditions and limited aviation operations during instrument weather conditions.

TOE 01457A0
Light Utility Aviation Company
Corps Aviation Group

Mission. Provides light utility aircraft to a division aviation brigade for moving personnel and equipment supporting command, control, liaison, courier, staff transport, and communications operations.

Assignment. Organic to a light utility aviation battalion, corps aviation group.

Basis of allocation. Four per medium helicopter battalion.

Capabilities.

• Conducts continuous (day and night) operations during visual and marginal weather conditions and limited operations during instrument weather conditions supporting combat operations.

• Provides AVUM for eight organic UH-1 aircraft.

TOE 01628A0
Medium Helicopter Company
Aviation Brigade, EAC

Mission. Transports personnel, supplies, and equipment for supporting maneuver, CS, and CSS operations.

Assignment. Organic to a theater aviation battalion (USARSO).

Basis of allocation. One per theater aviation battalion.

Capabilities.

- Provides airlift for assault operations.
- Moves tactical forces (other than assault), field artillery or other fire support assets, tactical air defense systems, engineer equipment and personnel, and other resources for supporting CS operations.
- Moves general supplies, equipment, and personnel – including LOTS when applicable – for supporting CSS operations.
- Recovers disabled aircraft and other critical equipment, including captured enemy equipment.
- Augments aeromedical evacuation when medical aircraft are inadequate or not readily available.
- Moves nuclear, chemical, and other special munitions.
- Evacuates noncombatants when directed by the applicable commander/authority.
- Self deploys all organic CH-47D helicopters to a theater of operations when the aircraft have been equipped for extended flight.
- Conducts continuous (day and night) operations during visual and marginal weather conditions and limited operations during instrument weather conditions.

MOTOR TRANSPORT

TOE 55158L0
Transportation Motor Transport Company
Airborne Division

Mission.

- Transports by truck Class I, II, III packaged, IV, VII, and IX supplies within the division area.
- Transports troops supporting division operations.
- Transports division reserve supplies for which the support battalion is responsible.
- Furnishes vehicles to assist division elements with a requirement for supplemental transportation, to include emergency unit distribution of Class V supplies and water.

Assignment. Organic to support battalion, airborne division.

Capabilitiy. See Table A-1, page A-9.

TOE 55168L0
Transportation Motor Transport Company
Air Assault Division

Mission.

- Transports Class II, IV, VII, and IX supplies for unit distribution.
- Transports troops supporting division operations.
- Transports the division reserve supplies for which the supply and transport battalion is responsible.
- Furnishes vehicles to assist division elements with a requirement for supplemental transportation to include emergency unit distribution of water and Class V supplies.

Assignment. Organic to support battalion, air assault division.

Capabilities. See Table A-1, page A-9.

TOE 55178L0
Transportation Motor Transport Company
Light Division

Mission. Transports Class II, IV, VII, and IX supplies for unit distribution. Transports troops supporting division operations and transports the division reserve supplies for which the support battalion is responsible. Supplements transportation for division elements to include emergency unit distribution of Class V and water.

Assignment. Organic to support battalion, light division.

Capabilities. See Table A-1, page A-9.

TOE 55188L0
Transportation Motor Transport Company
Heavy Division

Mission. Transports supplies and moves heavy and/or outsize vehicles and cargo. Also furnishes vehicles to assist division elements requiring supplemental transportation to include emergency unit distribution of Class V.

Assignment. Organic to an MSB, heavy division.

Capabilities. See Table A-1.

Table A-1. Divisional TC truck company SRC capability

TOE	DISPATCHES PER DAY			SINGLE LIFT TONS		PAX	VEH	REMARKS 1, 2
	TRK CGO	TRAC/ STLR	HET	GEN	AMMO			
LEVEL 1 CAPABILITY								
55138L000	34	25	5	224	391	1,577	5	3, 4
55158L000	34	10		135	174	801		3
55168L000	34	8		143	245	984		3
55178L000	28	7		117	200	804		3
55188L000	31	28	18	226	396	1,597	18	3, 4
LEVEL 2 CAPABILITY								
55138L000	32	24	5	212	370	1,491	5	3, 4
55158L000	32	10		127	164	921		3
55168L000	32	8		135	231	930		3
55178L000	27	6		110	189	760		3
55188L000	29	26	18	213	374	1,510	18	3, 4
LEVEL 3 CAPABILITY								
55138L000	29	22	5	191	333	1,344	5	3, 4
55158L000	29	9		115	148	830		3
55168L000	29	7		122	209	838		3
55178L000	24	6		99	171	685		3
55188L000	26	24	18	192	337	1,361	18	3, 4

Notes:
1. All data rounded to nearest whole number.
2. TMT companies generally do not perform line- or local-haul missions as defined in doctrine; they are organic to the division.
3. These units normally do not transport ammunition.
4. HETs used for evacuation missions – one tank per HET.

TOE 55540LE
Detachment LE
Trailer Transfer Point

Mission. Operates a TTP supporting line-haul motor transport operations.

Assignment. To a transportation composite group, attached to a motor transport battalion.

Basis of allocation. As required, based on capabilities.

Capabilities. Operates on a single-shift basis a transfer point with a maximum capacity of 125 semitrailers in and out. Operation includes:

- Receiving, segregating, assembling, and dispatching loaded or empty semitrailers for convoys.
- Maintaining POL dispensing facilities to refuel operating equipment.
- Servicing, inspecting, and if required, making emergency repairs to incoming vehicles.
- Preparing and maintaining required operational records and reports.

TOE 55716L0
Headquarters and Headquarters Detachment
Transportation Motor Transport Battalion

Mission. Commands, controls, and supervises units performing all types of motor transport operations.

Assignment. To a corps, attached to a corps support group; or to a TRANSCOM, attached to a transportation composite group.

Capabilities.

- Commands, controls, and supervises three to seven transportation companies and attached support units, or a combination thereof.
- Plans and schedules requirements to conform with the overall movement program.
- Translates transportation requirements from higher headquarters into specific vehicles or units required.
- Evaluates highway traffic plans affecting road movement – to include terrain, road condition, and security.
- Supervises operations of truck terminals, TTPs, and/or a trailer relay system.

TOE 55719L
Light Medium Truck Company

Mission. Transports noncontainerized cargo and personnel by truck.

Assignment. To a COSCOM, attached to a headquarters and headquarters detachment, corps support battalion. May also be assigned to a TRANSCOM and attached to a transportation battalion.

Capabilities. See Table A-2, page A-12.

TOE 55727L
Transportation Medium Truck Company

(TOE 55727L100–40-foot Container/Cargo Medium Truck Company; TOE 55727L200–7,500-gallon Petroleum Medium Truck Company.)

Mission. Transports containerized and noncontainerized dry cargo or bulk water when organized under TOE 55727L100; bulk petroleum products when organized under TOE 55727L200.

Assignment. To a TRANSCOM or a Transportation Composite Group (TOE 55622L). Normally attached to a headquarters and headquarters detachment, TMT battalion, or to a quartermaster POL battalion, or to a quartermaster water battalion.

Capabilities. See Table A-2, page A-12.

TOE 55728L
Transportation Medium Truck Company

(TOE 55728L100–20-foot Container/Cargo Medium Truck Company; TOE 55728L200–5,000-gallon Petroleum Truck Company; TOE 55728L300–PLS Medium Truck Company.)

Mission. Transports containerized and noncontainerized general cargo and bulk water when organized under TOE 55728L100; bulk petroleum products when organized under TOE 55728L200; and noncontainerized loads of ammunition and general cargo when organized under TOE 55728L300.

Assignment. To a COSCOM or a Transportation Composite Group (TOE 55622L). Normally attached to a headquarters and headquarters detachment of a TMT battalion; petroleum supply battalion, or quartermaster water battalion.

Capabilities. See Table A-2, page A-12.

TOE 55739L1
Transportation Combat Heavy Equipment Transport Company

(TOE 55739C100 when organized as 4 platoons/12 squads; TOE 55739L200 when organized as 2 platoons/6 squads.)

Mission. Relocates heavy maneuver forces on the battlefield.

Assignments.

- For operational relocation missions, assigned to a TRANSCOM and attached to a TMT battalion.
- For tactical relocation missions, assigned to corps and attached to a TMT battalion.

Capabilities. See Table A-2, page A-12.

RAIL TRANSPORT

TOE 55916L000
Headquarters and Headquarters Detachment Transportation Railway Battalion

Mission. Commands, controls, and supervises rail operating companies.

Assignment. Assigned to a TA; attached to a transportation command or a transportation group (composite).

Capabilities. On a round-the-clock basis, this unit commands, controls, and provides technical supervision to three to eight assigned or attached transportation rail companies.

URS 55917L000
Transportation Railway Operating Company

Replaces TOE 55918L000, 55919L000, and 55927L000. The new railway operating company provides the capability for all rail operations in one unit.

Mission.

- Operates railway locomotives and trains.
- Maintains and repairs railway track.
- Conducts running inspections on rolling stock and diesel-electric locomotives.
- Maintains rolling stock and diesel-electric locomotives.

Assignment. Assigned to a transportation composite group; normally attached to a transportation railway battalion.

Capabilities. Operates a rail division of approximately 40 to 60 miles (65 to 96 kilometers). The unit:

- Dispatches all trains, supervises on-line operations, and operates railway stations and signal towers within its railway division.
- Operates trains and locomotives for yard, road, and incidental switching service.
- Provides eight train crews for road service, terminal operations, or port clearance – to include switching, classifying, and making up trains for the road.
- Maintains and repairs track and roadbeds.
- Repairs major track damage.
- Performs maintenance on diesel-electric locomotives and railway cars, completing running repairs on 16 diesel-electric locomotives and 320 railway cars annually.
- Performs running inspections on 800 railway cars daily.

Table A-2. Nondivisional TC truck company SRC capability data

TOE	CONTAINERS 40 FT	CONTAINERS 20 FT	CONTAINERIZED TONS/DAY GENERAL 40 FT	CONTAINERIZED TONS/DAY GENERAL 20 FT	CONTAINERIZED TONS/DAY AMMO 40 FT	CONTAINERIZED TONS/DAY AMMO 20 FT	BB TONS/DAY GEN	BB TONS/DAY AMMO	GALS/DAY POL	GALS/DAY WATER	PAX PER LIFT	TRIPS PER DAY
55719L000		17		110			336	576			1,155	
55727L100/200	105	210	1,619	1,359		2,919	737	1,324	787,500	479,850	2,625	
55728L100/200		102		658			487		508,200	304,920	1,779	
55728L300								1,911				
55739L100												86
55719L000		34		219			673	1,151				
55727L100/200	210	420	3,238	2,717		5,838	1,474	2,648	1,575,000	959,700		
55728l100200		203		1,315			974		1,016,400	609,840		
55728L300								3,823				
55739L100												NA
55719L000		16		104			318	544			1,155	
55727L100/200	99	199	1,532	1,286		2,762	698	1,253	745,200	454,075	2,625	
55728L100/200		96		622			460		480,600	288,360	1,779	
55728L300								1,833				
55739L100												78
55719L000		32		207			636	1,088				
55727L100/200	199	397	3,064	2,571		5,524	1,395	2,506	1,490,400	908,150		
55728L100/200		192		1,244			921		961,200	576,720		
55728L300								3,666				
55739L100												NA
55719L000		14		93			287	490			985	
55727L100/200	90	181	1,393	1,169		2,512	634	1,139	677,700	412,945	2,259	
55728L100/200		87		561			415		433,200	259,920	1,516	
55728L300								1,675				
55739L100												69

Table A-2. Nondivisional TC truck company SRC capability data (continued)

TOE	CONTAINERS		CONTAINERIZED TONS/DAY				BB TONS/DAY		GALS/DAY		PAX PER LIFT	TRIPS PER DAY
			GENERAL		AMMO							
	40 FT	20 FT	40 FT	20 FT	40 FT	20 FT	GEN	AMMO	POL	WATER		
LEVEL 3 LOCAL HAUL												
55719L000		29		187			573	981				
55727L100/200	181	361	2,787	2,339		5,024	1,269	2,279	1,355,400	825,890		
55728L100/200		173		1,121			830		866,400	519,840		
55728L300								3,350				
55739L100												NA

Notes:

1. The data in the cells for each SRC represent exclusive capability. For example, the Level 1 line-haul capability for 55727L200 is 105 forty-foot containers per day or 210 twenty-foot containers per day or an intermediate value reflecting a combination. But, if the unit is carrying containers, it cannot carry break-bulk cargo. POL units (727L200) cannot carry any other type of cargo, and if the cargo trucks are equipped with SMFTs, the unit cannot carry any cargo other than water.
2. Semitrailers only carry passengers in emergency conditions. Cargo trucks routinely carry them. The pax data represents a single lift for each type unit using all the available trucks.
3. The data in this table is rounded. Normally, local-haul capability for a unit is exactly double the line-haul capability. When this data is recorded in a TOE section 1, it will be further rounded.

TOE 55918L
Transportation Railway Engineering Company

Mission. Maintains and repairs railway track, bridges, and buildings, within a railway division.

Assignment. Assigned to a transportation railway battalion.

Capabilities. At level 1, performs maintenance, repair, and limited construction of track, bridges, buildings, and structures of a railway division approximately 90 to 150 miles (145 to 240 kilometers) long.

TOE 55919L
Transportation Railway Equipment Maintenance Company

Mission. Inspects, services, and makes running repairs on diesel-electric locomotives and rolling stock.

Assignment. Assigned to a transportation railway battalion.

Capability. This unit:

- Performs daily and annual running repairs on diesel-electric locomotives.
- Performs daily running inspections on railway cars.
- Performs limited repairs to railway-peculiar tools and equipment within the railway division.
- Provides train wreck support to the railway division.

TOE 55927L
Transportation Train Operating Company

Mission. Operates railway locomotives and trains.

Assignment. Attached to a transportation railway battalion.

Capability. Provides 50 train crews daily for road or terminal operations. Duties include switching, classifying, and making up trains for the road.

WATER TRANSPORT AND TERMINAL OPERATIONS

TOE 55816L0
Headquarters and Headquarters Company Transportation Terminal Battalion

Mission. Commands, controls, and supervises attached units operating a water terminal.

Assignment. To a TRANSCOM, normally attached to a transportation composite group.

Capabilities. This unit:

- Commands, controls, and supervises attached units required to unload up to four ships simultaneously at an established water terminal or up to two ships simultaneously at a LOTS site.
- Provides the command element for operating intermediate staging areas of airborne units.
- Provides the command element for operating inland waterways and supporting amphibious operations.

TOE 55817L1
Transportation Cargo Transfer Company

(Will be replaced by 55819L.)

(TOE 55817L100 when organized to operate one terminal; TOE 55817L200 when organized to operate three terminals.)

Mission. Transships cargo at air, rail, and motor terminals.

Assignment. To a TRANSCOM. Normally attached to a motor transport, terminal, or corps support battalion.

Capabilities. This unit:

- Under SRC 55817L100, operates a single terminal on a 24-hour basis. It can transship 1,000 STONs of break-bulk cargo or 150 containers daily.
- Under SRC 55817L200, operates up to three separate terminals on a 24-hour basis.
- Redocuments transshipped cargo or containers.
- Stuffs and unstuffs containers.

TOE 55818L0
Transportation Terminal Service Company (Break-bulk)

(Will be replaced by 55819L.)

Mission. Discharges, backloads, and transships break-bulk cargo at water terminals located at beaches or fixed ports.

Assignment. To a TRANSCOM when employed to support independent corps operations. Normally attached to a transportation terminal battalion.

Capabilities. On a two-shift basis, with 75 percent operational availability of all mission equipment, this unit:

- In a LOTS operation, discharges 1,600 STONs of break-bulk cargo or backloads at the same rate, or simultaneously discharges 800 STONs of break-bulk cargo and backloads 800 STONs of break-bulk cargo.
- In a fixed port operation, discharges 2,500 STONs of break-bulk cargo or backloads at the same rate, or simultaneously discharges 1,250 STONs of break-bulk cargo and backloads 1,250 STONs.
- Sorts break-bulk cargo by destination and loads break-bulk cargo from the marshaling yards on land transportation.
- Provides limited in-transit storage.

TOE 55819L0
Transportation Cargo Transfer Company

(Will replace TOE 55817L, 55818L, and 55827L.)

Mission. Discharges, loads, and transships cargo at air, rail, truck, or water terminals; operates A/DACGs;

supplements cargo handling operations at CSS activities in corps and division areas to alleviate cargo backlogs.

Assignment. To a transportation composite group, or to a corps support command when supporting independent corps operations. Normally attached to a motor transport, corps support, or terminal battalion.

Capabilities. This unit operates up to four rail, truck, or air terminals on a 24-hour per day basis. The size of the terminal and/or scope of the operation may mean that more than one platoon is required to operate a given terminal. Daily capability is as follows:

- In rail or truck terminal operations transship 820 STONs of break-bulk cargo or 200 containers per terminal for a four-terminal total of 3,280 STONs of break-bulk cargo or 800 containers or combination thereof.
- In air terminal operations – transship 550 STONs of noncontainerized cargo or 160 20-foot container equivalents per terminal for a four-terminal total of 2,200 STONs of noncontainerized cargo or 640 20-foot container equivalents or combination thereof.
- In a fixed port water terminal, accomplish one, but not all:
  - Given a container ship and pierside cranes, discharge or load 500 containers per day or combination thereof.
  - When augmented by the port operations cargo detachment, discharge or load 2,500 STONs of break-bulk cargo. In simultaneous operations, move 1,250 STONs in each direction.
  - With a RORO ship, discharge up to 1,000 vehicles or load up to 750 vehicles.
- In a LOTS operation, augmented by the port operations cargo detachment, accomplish one but not all:
  - Discharge or load 300 containers. In simultaneous operations move 150 containers in each direction.
  - Discharge or load 1,500 STONs of break-bulk cargo. In simultaneous operations move 750 STONs in each direction.
  - Discharge or load 350 vehicles from or to a RORO ship.
- At inland terminals, perpetuates cargo documentation and redocuments diverted or reconsigned cargo.
- During container operations, stuffs and unstuffs containers. However, this capability degrades other capabilities.

TOE 55827L0
Transportation Terminal Service Company
(Break-bulk and Container)

(Will be replaced by 55819L.)

Mission. Discharges, backloads, and transships break-bulk and containerized cargo at water terminals located at fixed ports or in LOTS operations.

Assignment. To a TRANSCOM when employed to support independent corps operations. Normally attached to a transportation terminal battalion.

Capabilities. On a two-shift basis, with 75 percent operational availability of all mission equipment, this unit:

- In a LOTS operation when supported by a heavy crane platoon:
  - Discharges 200 containers or backloads at the same rate, or simultaneously discharges 100 containers and backloads 100 containers.
  - Discharges 1,600 STONs of break-bulk cargo or backloads at the same rate, or simultaneously discharges 800 STONs of break-bulk cargo and backloads 800 STONs.
  - Sorts break-bulk and containers by designation, loads break-bulk cargo and containers from the marshaling yards on land transportation, and stuffs and unstuffs containers on a limited basis.
  - Receives and processes containers for retrograde.
  - Provides limited in-transit storage.
- In a fixed port operation, when supported by a heavy crane platoon:
  - Discharges 400 containers or backloads at the same rate, or simultaneously discharges 200 containers and backloads 200 containers.

– Discharges 2,500 STONs of break-bulk cargo or backloads at the same rate, or simultaneously discharges 1,250 STONs of break-bulk cargo and backloads 1,250 STONs.

• Sorts break-bulk and containers by designation, loads break-bulk cargo and containers from the marshaling yards on land transportation, and stuffs and unstuffs containers on a limited basis.

• Receives and processes containers for retrograde.

• Provides limited in-transit storage.

TOE 55828L0
Transportation Medium
Watercraft Company

Mission. Provides and operates landing craft for transporting personnel and cargo in Army water terminal operations and Army waterborne tactical operations; augments, when required, Naval craft in joint amphibious operations.

Assignment. To a TRANSCOM. Normally attached to a transportation terminal battalion.

Capabilities. On a 24-hour basis, this unit:

• Transports an average of 1,000 STONs of noncontainerized cargo based on an average of 42 STONs per landing craft, each making two trips daily.

• Transports 240 20-foot containers per day based on one container per landing craft each making 20 trips daily.

• Transports 2,400 combat equipped troops, each making one trip per day.

TOE 55829L0
Transportation Heavy
Watercraft Company

Mission. Provides and operates landing craft for transporting personnel, containers, and outsized cargo in offshore discharge operations and lighterage service.

Assignment. To a TRANSCOM normally attached to a transportation terminal battalion. May be attached in support of a joint amphibious operation, or may operate separately under an appropriate commander.

Capabilities. On a 24-hour basis, this unit:

• Transports 1,600 STONs of noncontainerized cargo, each making one trip daily.

• Transports 288 containers, each making 7.2 trips daily.

• Transports 3,200 combat equipped personnel, each making one trip daily.

APPENDIX B
ORDERS, PLANS, AND SOP FORMATS

This appendix contains formats (Figures B-1 through B-12) that have been condensed for the transportation planner. As a rule, these formats apply only in the initial stages of planning. See AR 380-5 for classification procedures.

____
(Classification)

Copy ___ of ___ copies
Issuing headquarters
Place of issue (may be in code)
Date-time group of signature
Message reference number

OPERATION PLAN (ORDER): Type and serial number. (Type is usually indicated for combined or joint operations but omitted for a single service. When required, a code title may also be included.)

References: Maps, charts, and other relevant documents.

Time zone used throughout the order: ________________________

Task organization: Task subdivisions or tactical components of the command. (When a task organization is not listed, this information is included in paragraph 3 or in an annex. If an annex is used, indicate "Annex A (Task Organization).")

1. SITUATION. General information on the overall situation required to understand current circumstances.

a. Enemy Forces. Composition, disposition, location, movement, estimated strength, identification, and capability.

b. Friendly Forces. Information on forces, other than those covered by this order, that may directly affect actions of subordinates.

c. Attachments and Detachments. Units attached to or detached from the issuing unit (if not shown under task organization) and effective times. (If shown under task organization, appropriate reference is listed here.)

2. MISSION. A clear, concise statement of the task and its purpose.

Figure B-1. Operation plan (order) format

3. EXECUTION.

a. First Subparagraph. The commander's intent. A statement of what the commander wants to accomplish.

b. Second Subparagraph. The operation's concept, including the commander's general plan for developing and phasing the operation, using fire support, instructing on preparatory fires, and designating unit making the main effort.

c. Following Subparagraphs. Specific tasks of each element charged with tactical missions, including the combat organization (if not given under task organization).

d. Final Subparagraph (Coordinating Instructions). Details of coordination and control measures applicable to the command as a whole. Also – to avoid repetition – coordinating and operating instructions that apply to two or more elements.

4. SERVICE SUPPORT. A statement of CSS instructions and arrangements supporting the operation. Also the commander's direction to CSS commanders. If lengthy, details may be included in an annex and referenced here. At higher levels of command, reference may be made to an administrative/ logistics order.

a. Materiel and Services.
b. Medical Evacuation and Hospitalization.
c. Personnel.
d. Civil-Military Cooperation.
e. Miscellaneous.

5. COMMAND AND SIGNAL. Command and C-E operation instructions.

a. Command. Command post locations and axis of CP displacement, if not shown on an accompanying overlay. Liaison requirements, designation of alternate CP, and succession of command, if not adequately covered in the SOP.

b. Signal. Rules on use of communications and other electronic equipment (for example, radio silence). May refer to an annex, but, as a minimum, should list the current SIGNAL OPERATING INSTRUCTIONS index.

Acknowledgment Instructions.

/s/ ______________________
Commander (name and rank)

Authentication:
Annexes:
Distribution:

____
(Classification)

Figure B-1. Operation plan (order) format (continued)

____
(Classification)

(Change from oral orders, if any)

Copy ____ of ____ copies
Issuing headquarters
Place of issue (may be in code)
Date-time group of signature
Message reference number

ANNEX ____(SERVICE SUPPORT) to OPERATION ORDER NO ______

References: Maps, charts, and other relevant documents.

Time zone used throughout the order: ____________________

1. GENERAL

2. MATERIEL AND SERVICES
   a. Supply.
   b. Transportation.
   c. Services.
   d. Maintenance.
   e. Other (as necessary).

3. MEDICAL EVACUATION AND HOSPITALIZATION

4. PERSONNEL

5. CIVIL-MILITARY COOPERATION

6. MISCELLANEOUS

Acknowledgment instructions.

____
Last name of commander
Rank

Authentication:
Appendixes:
Distribution:

____
(Classification)

Figure B-2. Service support annex format

(Appendix issued with the annex)

____
(Classification)

APPENDIX 1 (TRAFFIC CIRCULATION AND CONTROL) to ANNEX E (SERVICE SUPPORT) to OPERATION ORDER 14-23d Armd Div

Reference: Map, series V762, UNITED STATES, sheet 4071 (UPTON), edition 3-AMS, 1:50,000.

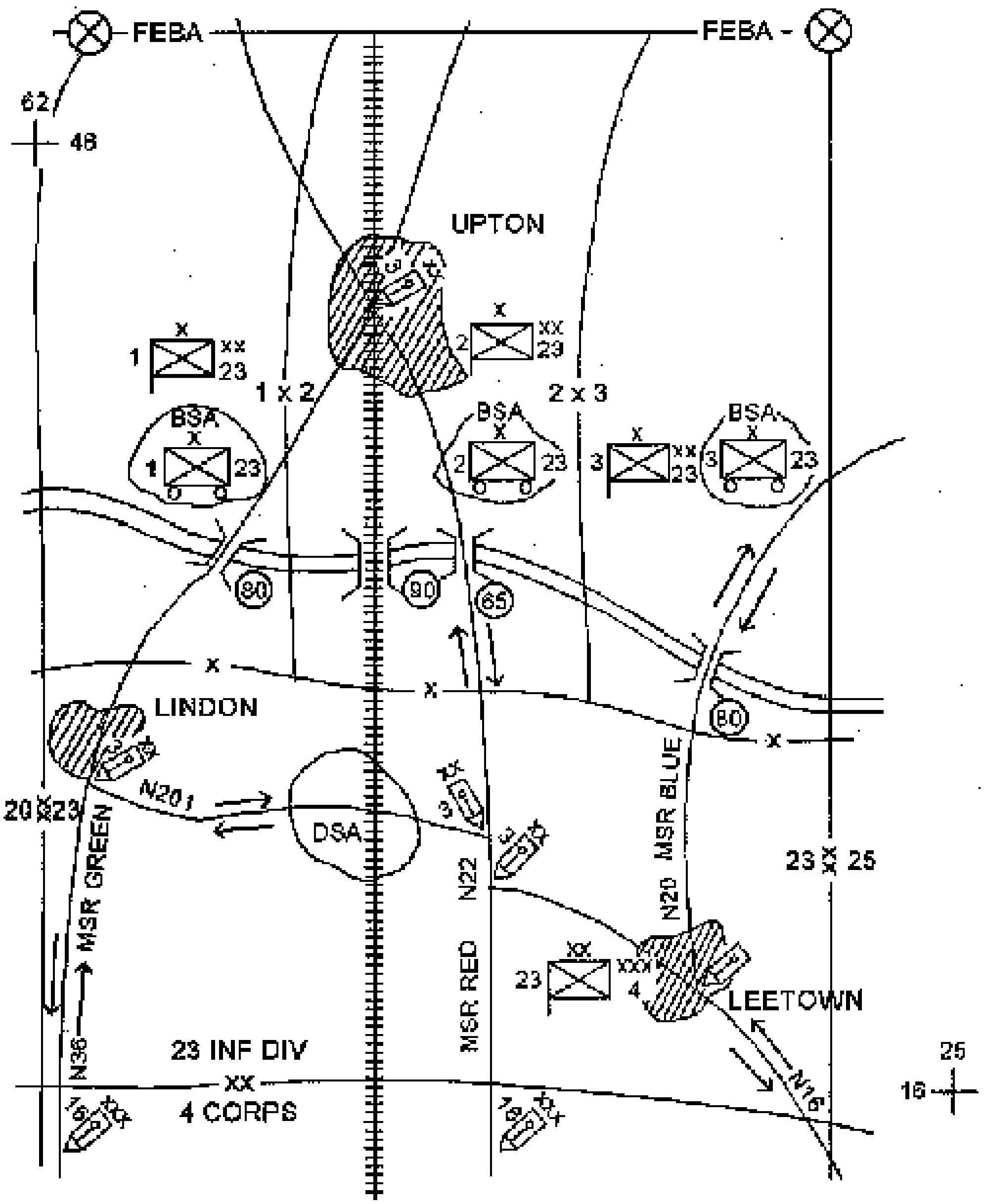


Figure B-3. Sample traffic circulation and control appendix to service support annex, division

(Classification)

(Change from oral orders, if any)[1]

Copy ____ of ____ copies
Issuin headquarters
Place of issue (may be in code)
Date-time group of signature (must include time zone suffix)[2]
Message reference number

ADMINISTRATIVE/LOGISTICS PLAN (ORDER) NO ______[3]

RELATED OPERATION PLAN (ORDER) NO _______ (when application).

References: Maps, charts, and other relevant documents.[4]

Time zone used throughout the pllan (order): ____________________

Composition and location of administrative and logistics service units. This information may appear here, in the appropriate paragraph of the order, or in a trace or overlay. If units are not listed here, this heading may be omitted.

Notes appear at end of plan.

1. SITUATION. A general statement of administrative and logistic factors affecting support of the operation. Information from paragraph 1 of the related operation plan or order which is essential to conbat service support.

a. enemy Forces. Composition, disposition, location, movements, estimated strength, an identification. (Reference to an operation order or to the intelligence annex to an operation order, if available.) Enemy capabilities that may influence the CSS mission.

b. Friendly Forces. Pertinent information on own forces that may directly influence the CSS mission, if not covered by a referenced operation order or included in subsequent paragraphs.

c. Attachments and Detachments.

d. Assumptions.[5]

2. MISSION. A clear, concise statement of the CSS task and its purpose.

3. GENERAL. An outline of the general plan for CSS an any orders not recovereed by succeeding paragraphs (for example, location of the division support area and coordinating agencies, genereal instructions for movement of installation).

Figure B-4. Administrative/logistics plan (order) format

4. MATERIEL AND SERVICES

a. Supply. Subparagraphs for each class of supply, maps, water, special supplies, excess materiel, salvage materiel, and captured enemy materiel. When applicable, each subparagraph contains–

- Location of the installations concerned with handling supplies and materiel for supported units.
- Opening and closing times.
- Operating units.
- Supported units.
- Levels of supply.
- Methods and schedules of distribution.
- Instructions for submission of routine reports concerning the supplies listed.
- Any other pertinent instructions or information needed by supported units.

Instructions and information for two or more classes may be included under one subparagraph if entries are limited and clarity is not sacrificed. For Class V, include designation and location of approving agency, controlled supply rate, prescribed nuclear load, and chemical munitions allocations, as appropriate.

b. Transportation.

(1) Location of terminals and installations (rail stations, airfields, ports, and beaches).[6]

(2) Operating units.

(3) Schedules (march tables, timetables, and entraining tables).

(4) Area responsibilities of transportation movement officers and movement regulating teams.

(5) Traffic control and regulation measures (regulations, restrictions, allocation priorities, regulating and control points).

(6) Designation of main supply route.

c. Services. Information and instructions for supported units – type of service available, designation and location of servicing unit or installation, support unit assignments, and service schedules, if applicable. Service missions for service units not covered in other orders (for example, priority of operating units and assignments to supported units). Special missions not covered in other orders.

(1) Construction.

(2) Graves registration. Collection points, evacuation procedures, and personal effects handling. Procedures for isolated burials and contaminated remains, if not contained in the unit SOP.

(3) Field services. Laundry, bath, clothing renovation and exchange, bakery, and decontamination.

(4) Health services. Medical, dental, veterinary services; laboratory and spectacle service, whole blood control, preventive medicine, and health and sanitation.

(5) Installation service. Real estate, repair and utilities, fire protection, sewage and trash disposal, and water supply.

(6) Other. Aviation, explosive ordnance disposal, photography, and procurement.

d. Labor. Policies and restrictions on using civilians, enemy prisoners of war (EPWs), and civilian internees and detainees; allocation and priorities of available labor; and designation and location of available labor units.

e. Maintenance. Include priority of maintenance, location of facilities, and collecting points.

Figure B-4. Administrative/logistics plan (order) format (continued)

5. MEDICAL EVACUATION AND HOSPITALIZATION. The plan for evacuation and hospitalization of sick, wounded, or injured military personnel.

a. Evacuation. The evacuation or holding policy. Responsibilities; evacuation routes, means, and schedules. Evacuation and en route treatment policies, when applicable. Specific policy for evacuation by air or ground and for evacuation of NBC-contaminated patients. Medical evacuation request procedures and channels, if different from SOP.

b. Hospitalization. List of all appropriate treatment facilities (dispensaries, aid stations, clearing stations, hospitals), their locations, and times of operation. Definitive treatment policies, including treatment of contaminated casualties, if established.

c. Other Services. Pertinent information on any other health services matters (dental, preventive medicine, medical supply, veterinary). Unit locations, support information, policies.

6. PERSONNEL. Information and instructions on personnel matters, including foreign civilian labor used in direct military support functions. Under each of the following subparagraphs are listed, when applicable–

- Installation, location, and times of operation.
- Operating units.
- Units or area served.
- Rest, leave, and rotation criteria; quotas allocated to units.
- Unit responsibility for movement or administration of personnel.
- Reports, requisitions or plans.
- References to previous order, instructions, or SOP.

a. Unit Strength.

(1) Strength reports. Instructions for submission of data required to keep the commander informed. Instructions include requirements for routine reports and special reports following a mass-destruction attack or a natural disaster.

(2) Replacements. A statement establishing validity of existing personnel requisitions. Instructions for submission of requisitions and for processing and moving replacements. Location of replacement units and the units each will support. Type and location of unit replacements under control of the issuing headquarters.

b. Personnel Management.

(1) Military personnel. Instructions on classification, assignment, promotion, transfer, reclassification, reduction, elimination, retirement, separation, training, rotation, and economic personnel use.

(2) Civilian personnel. A list of–

- Sources of civilian labor.
- Locations of civilian personnel offices or other labor administration centers and labor pools.
- Procurement policies and procedures.
- Restrictions on use of civilian labor.
- Administrative and control procedures.
- Pay schedules, allowances, and CSS to be provided.
- Responsibilities of subordinate commanders for administration.

Reference appropriate SOP.[7]

Figure B-4. Administrative/logistics plan (order) format (continued)

(3) EPWs and civilian internees and detainees. Instructions on collection, safeguarding, processing, evacuation, use, treatment, and discipline of EPWs and civilian internees and detainees and all other personnel arrested or captured but not immediately identifiable as POWs. Location of EPW and civilian internee facilities.

c. Morale. Instructions on leaves, rest and recreation facilities, decorations and awards, postal and finance services, chaplain activities, personal hygiene, morale support activities, post exchanges, and legal assistance.

d. Discipline, Law, and Order. Troop conduct and appearance. Control and disposition of stragglers, including location of straggler collecting points and special instruction for augmenting straggler control during mass-destruction attacks. Administration of military justice and relations between military and civilian personnel (fraternization, black marketing, selling government property, and respect for local laws).

e. Headquarters Management. Instructions on movement, spaced arrangement, organization, and operation. Allocation of shelter for the headquarters and for troops in the headquarters area.

f. Miscellaneous. Personnel administrative matters not specifically assigned to another coordinating staff section or included in the preceding subparagraphs.

7. CIVIL-MILITARY COOPERATION. Allocation of civil affairs units, control of refugees, and feeding and treatment of the civilian population.

8. MISCELLANEOUS. Special instructions not covered above.

a. Boundaries. Location of rear boundary and any other boundary needed for CSS purposes.

b. Protection. Measures established for protection of CSS units and installations. Usually, an announcement of the tactical unit providing the protection, CSS units or installations receiving the protection, and any limitations to the protection.[8] Pertinent instructions from the rear area protection plan or reference to an annex.

c. Special Reports. Reports not included in previous paragraphs and those reports requiring special emphasis.

d. Statement. Include time or conditions under which the plan is to be placed in effect.[2]

9. COMMAND AND SIGNAL. Headquarters location and movements, liaison arrangement, recognition and identification instructions, and general rules on use of communications and other electronic equipment, if necessary. An annex may be used when considered appropriate.

Acknowledgment instructions.

/s/ ______________________________

Commander (name and rank)[9]

Authentication: [10]

Annexes:

Figure B-4. Administrative/logistics plan (order) format (continued)

Distribution:

[1] Applicable only to an order. The phrase "No change from oral orders" or ''No change from oral orders except paragraph_____ " will appear here if oral orders have been issued concerning this operation. In the absence of oral orders, this space is left blank.

[2] This is the time the commander actually signs the plan or order and is the effective time of the order unless stated otherwise in paragraph 8.

[3] The type of administrative/logistics plan (order) indicates whether it is Navy, Army, Air Force, combined, or joint. For a single service, the type of administrative/logistics order is normally omitted. When required, a code title may also be included.

[4] Reference to a map should include the map series number and, if required, the country or geographic area, sheet number, name, edition, and scale.

[5] Applicable only to a plan.

[6] Items listed in this subparagraph are not limited necessarily to transportation operations and may include ocean, inland waterway, coastal, highway, air, rail, pipeline, and miscellaneous activities.

[7] 0r provide specific pay scales and other conditions of employment in an annex.

[8] This announcement is information for CSS units, not an order to the tactical unit involved.

[9] The commander's last name and rank appear on all copies. The original (copy number 1) must be signed by the commander or a specifically authorized representative. If the chief of staff signs the original, the phrase "FOR THE COMMANDER'' is added. The signed copy is the historical copy that remains in the headquarters files.

[10] If the commander or his authorized representative signs a master copy which permits automatic reproduction of the signed document, no further authentication is required. If the signature is not reproduced, authentication by the preparing staff officer is required on all subsequent copies. The commander's last name and rank appear typed in the signature block.

(Classification)

Figure B-4. Administrative/logistics plan (order) format (continued)

____

(Classification)

(Change from oral orders, if any)

Copy ____ of ____ copies
Issuing headquarters
Place of issue (may be in code)
Date-time group of signature
Message reference number

ROAD MOVEMENT ORDER NO. ______
(OR: ANNEX ____ (ROAD MOVEMENT) to OPERATION ORDER NO ____)

References: Maps, tables, and other relevant documents.

Time zone used throughout the order: ______________________

Task organization:

1. SITUATION
   a. Enemy Forces.
   b. Friendly Forces.
   c. Attachments and Detachments.

2. MISSION

3. EXECUTION
   a. Commander's Intent.
   b. Concept of Movement.
   c. Tasks of Subordinate Unit.
   d. Detailed Timings.
   e. Coordinating Instructions.
      (1) Order of march.
      (2) Routes.
      (3) Density.
      (4) Speed.
      (5) Method of movement.
      (6) Defense for move.
      (7) Start, release, or other critical points.
      (8) Convoy control.
      (9) Harbor areas. [1]

Figure B-5. Road movement order or annex format

(10) Halts.
(11) Lighting.
(12) Air support.
f. Other (as necessary).

4. SERVICE SUPPORT
a. Traffic Control.
b. Recovery.
c. Medical.
d. Petroleum, Oil, and Lubricants.
e. Water.

5. COMMAND AND SIGNAL
a. Commanders.
b. Communications.
c. Position of Key Vehicles.

Acknowledgment instructions.

Last name of commander
Rank

Authentication:
Appendixes:
Distribution:

[1] A harbor area is a space set aside for normal halts, traffic control, and emergency congestion relief. Harbor areas are used–

- To hold vehicles at both ends of a crossing or defile.
- To make changes in density, especially at first or last light.
- To contain spillovers in serious delays (likely to be caused by enemy air attack or its results).
- To allow columns to rest and carry out maintenance and decontamination.
- To allow elements to change position in column if there is a change in priorities.

(Classification)

Figure B-5. Road movement order or annex format (continued)

(Annex issued with the operation order)

(Classification)

APPENDIX 1 (ROAD MOVEMENT TABLE) to ANNEX K (ROAD MOVEMENT) to OPORD 9 – 20th Inf Div

Reference: Map, series M504, AFGAN, sheet 4842 (BHAD-WURST), edition 1-DMG, 1:100,000

Time zone used throughout the order: ZULU.

General Data:

1. Average Speed: 20 KPH.
2. Traffic Density: 20 VPK.
3. Halts: SOP.
4. Routes:
   a. Route RED. Serials: 1, 3, 4, and 5.
   b. Route BLUE. Serials: 2 and 6.
5. Critical Points:
   a. Route RED.
      (1) Start point: RJ 413 at MB201699.
      (2) Release point: RJ 211 at QA990628.
      (3) Other critical points.
         (a) RJ (VILLERS) at MB 330718.
         (b) RJ 242 at NB455701.
         (c) RJ (LAWST) at DA585692.
         (d) BLUE River bridge at PA683686.
      (4) Route classification: 6 x 50.
      (5) Route restrictions: BLUE River bridge – 6 x 50.
   b. Route BLUE.
      (1) Start point: RJ 526 at MS229509.
      (2) Release point: RJ 105at RS981511.
      (3) Other critical points.
         (a) RJ 592 at MS334481.
         (b) RJ (CHANCE) at NS401490.
         (c) RJ (VEGAS) at QT790501.
         (d) BLUE River bridge at RS860495.
      (4) Route classification: 10 x 50.
      (5) Route restrictions: BLUE River bridge – 6 x 50.
6. Main Routes to Start Points: ***
7. Main Routes from Release Points: ***

NOTES

1. Only the minimum number of headings should be used. Include any information common to two or more movement numbers under the general data paragraphs.

2. Since the table may be issued to personnel concerned with traffic control, security must be remembered. It may not be desirable to include dates or locations.

3. If the table is issued by itself, not as an annex to a more detailed order, the table must be signed or authenticated in the normal way.

4. Critical point is defined as “a selected point along a route used for reference in giving instructions.” Critical points include start points, release points, and other points along a route where interference with movement may occur or where timing is critical.

5. The movement number identifies a column or element of column during the whole of the movement.

Figure B-6. Sample road movement table appendix to road movement annex, division

MOV NUMBER	DATE	UNIT	NUMBER OF VEHICLES	LOAD CLASS OF HEAVIEST VEHICLE	FROM	TO	ROUTE	ROUTE TO START POINT	CRITICAL POINTS REF	CRITICAL POINTS DUE	CRITICAL POINTS CLEAR	ROUTE FROM RELEASE POINT	REMARKS
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
1	•••	1st Bde	•••	•••	BHAD	WURST	RED	•••	SP	0530	0635	•••	•••
		COL Long,			area	area			RJ (VILLERS)	0610	0715		
		Cdr							RJ242	0630	0735		
									RJ (LAWST)	0715	0820		
									BLUE River bridge	0755	0900		
									RJ (HAINS)	0815	0920		PST 65 min
									RP	0855	1000		
2	•••	2d Bde	•••	•••	BHAD	WURST	BLUE	•••	SP	0530	0635	•••	•••
		COL Corley,			area	area			RJ592	0548	0653		
		Cdr							RJ (CHANCE)	0630	0735		
									RJ (VEGAS)	0800	0905		
									BLUE River bridge	0840	0945		PST 65 min
									RP	0920	1025		
3	•••	3d Bde	•••	•••	BHAD	WURST	RED	•••	SP	0650	0755	•••	•••
		COL Smith,			area	area			RJ (VILLERS)	0730	0835		
		Cdr							RJ242	0750	0755		
									RJ (LAWST)	0835	0940		
									BLUE River bridge	0915	1020		
									RJ (HAINS)	0935	1040		PST 65 min
									RP	1015	1120		
4	•••	Div Arty	•••	•••	BHAD	WURST	RED	•••	SP	0810	0920	•••	•••
		COL Stephens,			area	area			RJ (VILLERS)	0850	1000		
		Cdr							RJ242	0910	1020		
									RJ (LAWST)	0955	1105		
									BLUE River bridge	1035	1145		
									RJ (HAINS)	1055	1205		PST 70 min
									RP	1135	1245		
5	•••	Div Trp	•••	•••	BHAD	WURST	RED	•••	SP	0935	1131	•••	•••
		LTC Camp,			area	area			RJ (VILLERS)	1015	1211		
		Cdr							RJ242	1035	1231		
									RJ (LAWST)	1120	1316		
									BLUE River bridge	1200	1356		
									RJ (HAINS)	1220	1416		PST 116 min
									RP	1300	1456		
6	•••	DISCOM	•••	•••	BHAD	WURST	BLUE	•••	SP	0944	1200	•••	•••
		COL Norling,			area	area			RJ592	1002	1218		
		Cdr							RJ (CHANCE)	1044	1300		
									RJ (VEGAS)	1214	1430		
									BLUE River bridge	1254	1510		PST 136 min
									RP	1334	1550		

Figure B-6. Sample road movement table appendix to road movement annex, division (continued)

STANDING OPERATING PROCEDURES

____
(command)

1. PURPOSE. Outline of purpose.

2. SCOPE. Application and coverage.

3. UNIT PROCEDURES. Action required by subordinate units in preparing unit SOP. A definite statement that SOP of subordinate units will be based on and conform to SOP of the issuing command.

4. RECISIONS. Any publications superseded or rescinded by the SOP, including fragmentary SOPs, orders, memorandums, bulletins, and other directives.

5. REFERENCES. Publications to be used with the SOP.

6. DEFINITIONS. Terms defined, if required to understand and interpret the SOP.

7. TRANSPORTATION ORGANIZATION. Missions, organizations, and functions (unless published elsewhere) of:
   a. Office of the Transportation Officer.
      (1) Transportation officer.
      (2) Deputy transportation officer or executive officer.
      (3) Staff sections.
      (4) Liaison officers.
   b. Field Installations.
      (1) Water terminals.
      (2) Transportation supply depots.
      (3) Transfer points and other special transportation activities.
      (4) Transportation movements branch and other transportation organizations.

8. ADMINISTRATION.
   a. General. Command policies and directives.
   b. Correspondence.
      (1) Types. Instructions for preparing, forwarding, and handling; paper economy measures.
      (2) Classified documents. Types of classification and authority to classify; handling, delivery, and receipting methods and procedures; security measures and responsibilities.
   c. Personnel.
      (1) General. Command policies and directives.
      (2) Local civilian labor. Command policies and administrative procedures for procurement, use, and pay; Geneva convention provisions.
      (3) Prisoners of war. Command policies and administrative procedures for procurement as labor; use, treatment, and security; Geneva convention provisions.
      (4) Replacements. Responsibilities and procedures for requisitioning transportation replacements, command policies and directives.
   d. Reports. Types of administrative reports required; method and frequency of submission (samples to be appended); control procedures.

Figure B-7. Transportation SOP format for major commands

9. INTELLIGENCE

a. General. Transportation intelligence purpose, mission, types; command directives.

b. Information Collection. Collection agencies, essential elements of information, sources, coordination, collection plan, methods, reporting and disposition of captured enemy material.

c. Information Processing. Responsibilities and procedures for recording, evaluating, and interpreting information.

d. Dissemination. Policies, methods, criteria, security classifications, transmissions, time considerations.

e. Use. General application of intelligence to transportation operations and planning; precautions against enemy counterintelligence.

f. Counterintelligence. Objectives, responsibilities, and application to the transportation service.

g. Reconnaissance. Purpose and responsibilities.

10. PLANS

a. Transportation Requirements. Responsibilities for maintaining current lists of transportation requirements for movement of the unit or its elements by rail, truck, inland waterway, and air.

b. Transport Availability. Responsibilities for maintaining current lists of available transportation – organic, assigned, or attached to the unit, including local civilian transportation.

c. Load Plans. Responsibilities of subordinate units for maintaining current load plans; designation of vehicles to transport personnel, supplies, and organizational equipment.

d. Traffic Circulation Plans. A statement that traffic circulation plans will be coordinated with traffic circulation plan of this headquarters.

e. Special Operations. A statement that transportation aspects of subordinate troop plans for special operations (for example, river crossing, pursuit, retrograde movement) will be coordinated with this headquarters.

f. Plans by Units in Reserve. Statements that plans by these units for forward or lateral movement will be coordinated with this headquarters.

g. Organizational Transportation Pool. Procedures, including availability reports, unit responsibilities for furnishing personnel, maintenance of equipment, and administrative support.

h. Civil Aid. A statement that services and subordinate units will submit plans in advance for movement of civilians and civil aid supplies and that plans will not be carried out without prior approval.

i. Main Supply Routes and Supply and Service Installations.

11. TRAINING

a. Responsibilities and procedures for preparing and supervising training programs of transportation units.

b. Responsibilities and procedures for exercising technical supervision over transportation training throughout the command.

12. REAR AREA OPERATIONS. Command policies and directives; responsibilities of units for BASE defense; defense against airborne operations, NBC attack, sabotage, infiltration, and guerrilla warfare; procedures for reporting enemy activity.

13. AMPHIBIOUS OPERATIONS

a. General. A statement that this SOP standardizes normal procedures for preparation and execution of amphibious operations and will apply unless otherwise prescribed.

(1) Subordinate units will issue SOPs which conform to this SOP.

(2) References.

Figure B-7. Transportation SOP format for major commands (continued)

b. Planning.

(1) Requirements of the tactical plan and the scheme of maneuver.

(2) Availability of landing craft and ships by type, size, cargo, and personnel capacity.

(3) Establishment of close liaison with the Navy and Air Force and with task force commanders.

(4) Landing force embarkation and tonnage; equipment and supplies breakdown from tables submitted by task force commanders.

(5) Unit loading and embarkation training arrangements and coordination.

(6) Movement of the embarkation areas and delivery of equipment and supplies, including waterproofing, marking, and palletizing.

(7) Supervision within the embarkation area.

(8) Buildup period for supplies and ship turnaround time.

(9) Alternate logistical procedures or an entire alternate plan to support alternate tactical plans being considered.

c. Movement to Staging Area.

(1) Warning orders.

(2) Movement method – rail, highway, air, water.

(3) Movement control.

d. Staging Area.

(1) Reception.

(2) Spot delivery of equipment.

(3) Control points which control flow of equipment and personnel to embarkation points or assembly areas.

(4) Assembly areas for temporary storage of equipment and supplies to be loaded on transports.

(5) Transportation for supplies and equipment from assembly areas to ships.

(6) Areas for final waterproofing.

(7) Facilities to prepare cargo not already processed for loading.

e. Embarkation of Troops.

(1) Movement to embarkation point or assembly areas.

(2) Control of movement to vessels.

f. Movement to Objective Area. In accordance with naval directives.

g. Ship-to-Shore Movement.

(1) Debarkation of equipment, supplies, and service troops at the proper time to support tactical operation.

(2) Control and landing of emergency supplies.

(3) Evacuation of casualties by water.

h. Beach Organization.

(1) Transportation unit reconnaissance party.

(2) Consolidation of supplies and transportation for subsequent logistical support of the landing force.

(3) Control.

(a) Vehicular traffic.

(b) Transfer operations (buildup area).

(4) Communication between beach organization and control vessel and ships.

Figure B-7. Transportation SOP format for major commands (continued)

14. INSPECTIONS

a. Reference. Higher headquarters SOP on inspections.

b. Purpose.

c. Policy.

d. Types. Vehicle use, transportation training, maintenance and maintenance support quality, operations efficiency, records system.

e. Frequency.

f. Before-Inspection Procedures.

g. After-Inspection Procedures.

h. Reports. A sample format, number of copies required, and distribution.

15. AIRBORNE OPERATIONS. Command policies and directives; responsibilities and procedures for transportation units participating in airborne operations.

16. COMMUNICATIONS

a. Communications for coordinating transportation.

b. Air-ground communications for coordinating airdrops and land transportation.

c. Reference to communications diagram.

/s/ ______________________________
Commander (name and rank)

Authentication:
Annexes:
Distribution:

Figure B-7. Transportation SOP format for major commands (continued)

STANDING OPERATING PROCEDURES

____
Unit

Section I. GENERAL

1. APPLICATION. Operations which SOP covers.
2. PURPOSE.
3. REFERENCES. FMs, TMs, SOPs of higher headquarters, other.
4. RESPONSIBILITY FOR PREPARATION, CHANGES, REVISIONS.
5. EFFECTIVE DATE.

Figure B-8. Transportation SOP format for units

Section II. COMMAND, STAFF, LIAISON

6. ORGANIZATION.

7. COMMAND POSTS.
   a. Normal location in relation to next higher headquarters.
   b. Change of location, – reporting; coordinates and time.
   c. Forward command posts.
      (1) Requirement.
      (2) Organization.
      (3) Personnel and equipment.

8. STAFF DUTIES.
   a. Staff officers.
   b. Special staff officers.

9. LIAISON.
   a. Duties of liaison officers.
   b. Unit responsibilities for liaison – higher, lower, and adjacent units.

10. PLANNING. Responsibilities.

Section III. ADMINISTRATION

11. CHAIN OF COMMAND.

12. REPORTS.
   a. Routine.
   b. Special.
   c. Submission.
      (1) Title and reports-control symbol.
      (2) Format.
      (3) Date due.
      (4) Number of copies.
      (5) Negative report, if required.

13. PROMOTION POLICIES.
   a. Officer.
   b. Enlisted.
   c. Battlefield.

14. COURTS-MARTIAL.
   a. Location of jurisdiction.
   b. Procedure for submitting cases.

15. MAIL.
   a. Handling official mail.
   b. Handling personal mail.

16. LEAVES AND PASSES.
   a. Command policy. Conduct, VD control.
   b. Authority.

Figure B-8. Transportation SOP format for units (continued)

17. JOURNALS AND HISTORY.
    a. Unit journal and history.
    b. Staff section journals.

18. MILITARY PUBLICATIONS. Distribution.

19. PRISONERS OF WAR
    a. Reference.
    b. Special instructions for capturing unit.

20. AWARDS AND DECORATIONS.
    a. Channels.
    b. Form.
    c. Presentation.

21. ORDERS.

22. BILLETS AND BIVOUACS.
    a. Policies. Occupation and clearance.
    b. Billeting party.

Section IV. MOVEMENT

23. HIGHER HEADQUARTERS SOP. Reference.

24. MOTOR MOVEMENT.
    a. Vehicles. Preparation for movement.
    b. Motor marches.
        (1) Strip maps.
        (2) Route reconnaissance.
        (3) Messing and refueling.
        (4) Night marches.
        (5) Makeup of march units and serials.
        (6) Vehicle gap.
        (7) Speed and rate of march.
            (a) Column rate of march.
            (b) Lead vehicle speed.
            (c) Permissible catch-up speed.
            (d) March unit or serial time length.
        (8) Posting traffic guards during halt.
    c. Infiltration.
    d. Personnel. Conduct during movement.
        (1) Passengers.
        (2) Drivers.

25. VEHICLE AND EQUIPMENT OPERATIONS.
    a. Motor pool.
        (1) Dispatch.
        (2) Service.
        (3) Maintenance.
    b. Administrative vehicles. Regulations.

Figure B-8. Transportation SOP format for units (continued)

26. RAIL MOVEMENTS.
   a. S1 Action. Movement policy.
   b. S2 Action.
      (1) Reconnaissance report.
      (2) Security.
   c. S3 Action.
      (1) Troop list.
      (2) Loading plan.
      (3) Transportation movement teams.
   d. S4 Action.
      (1) Transportation request.
      (2) Troop and guard mess.
      (3) Blocking and dunnage.
      (4) Shipping documents.
      (5) Rolling stock.
      (6) Loading schedules and area.

27. AIR MOVEMENT.
   a. S1 Action.
   b. S2 Action.
   c. S3 Action.
      (1) Aircraft required.
      (2) Loading plan.
      (3) Loading schedule and areas
      (4) Air-transportability technique.
   d. S4 Action.
      (1) Transportation request.
      (2) Availability of tie-down devices or material.
      (3) Weight-of-equipment data for loading computation.
      (4) Shipping documents.
      (5) Vehicles required to load and unload aircraft.

28. WATER MOVEMENT.
   a. S1 Action. Movement policy.
   b. S2 Action.
      (1) Reconnaissance report.
      (2) Security.
   c. S3 Action.
      (1) Troop list.
      (2) Loading plan.
      (3) Transportation movement teams.
   d. S4 Action.
      (1) Transportation request.
      (2) Troop mess.
      (3) Shipping documents.
      (4) Vessels required.
      (5) Loading schedule and area.

Figure B-8. Transportation SOP format for units (continued)

Section V. SECURITY

29. POLICIES AND RESPONSIBILITIES.

30. MOVEMENT SECURITY.
   a. Air guards.
   b. Manning of vehicular weapons.
   c. Camouflage during halts.
   d. Advance, flank, and rear guards.
   e. Action to be taken in attack.

31. BIVOUAC SECURITY.
   a. Camouflage.
   b. Mines and booby traps.
   c. Defensive positions.
   d. Joint security.
   e. Security plans.
   f. Sentry posts and outposts.

32. ATTACK WARNING SIGNALS.
   a. Air.
   b. Airborne.
   c. Mechanized.
   d. Troops.
   e. Nuclear, biological, chemical.

33. FIRE SAFETY AND FIRE FIGHTING.
   a. Plans.
   b. Fire personnel and duties.
   c. Safety rules (motor pool, kitchen, other).

34. ALERT PLANS.
   a. Unit plan.
   b. Alert roster.
   c. Armament and equipment.
   d. Alert warning phase system.

35. EQUIPMENT DESTRUCTION.

Section VI. COMMUNICATIONS

36. AVAILABLE COMMUNICATIONS MEANS.

37. ESTABLISHMENT OF COMMUNICATIONS.
   a. Organic communications.
   b. Area communications support.
   c. Responsibilities.

38. COMMUNICATIONS PROCEDURES.
   a. Voice radio.
   b. Radio and wire integration.
   c. Message.

Figure B-8. Transportation SOP format for units (continued)

d. Visual and sonic.
e. Reference to higher headquarters CEOI.

39. SIGNAL MAINTENANCE RESPONSIBILITIES.
a. Commander.
b. Signal/communications officer.
c. Operators.
d. Users.

Section VII. RECONNAISSANCE, INTELLIGENCE, AND COUNTERINTELLIGENCE

40. RECONNAISSANCE. Essential elements of information.

41. COMBAT INTELLIGENCE.
a. Definition of "spot reports."
b. Requirement for spot reports.
(1) Initial contact with enemy.
(2) Marked change in enemy disposition or situation.
(3) Armored, air, or airborne attack.
(4) New units identified.
(5) Enemy strength, composition, and movement.
(6) Location of enemy installations.
(7) Use of chemicals or new weapons.
(8) New materials or equipment.

42. COUNTERINTELLIGENCE.
a. Mail censorship.
b. Blackout discipline.
c. Information.
(1) To enemy captors.
(2) To press representatives.
d. Signs and countersigns.
e. Classified documents destruction.
f. Civilian control.
g. Secrecy discipline.

Section VIII. SUPPLY AND MAINTENANCE

43. CLASS I SUPPLY.
a. Ration pickup.
b. Daily ration return and cycle.
c. Reserve rations.
(1) Unit.
(2) Individual.

44. WATER.
a. Authorized source.
b. Expedient purification methods.
c. Water economy.

Figure B-8. Transportation SOP format for units (continued)

45. CLASS II AND IV SUPPLY.
    a. Requisition days for various services.
    b. Pickup procedure.
    c. Salvage turn-in procedures.
    d. Droppage by battle-loss certificate.

46. CLASS III SUPPLY.
    a. Resupply.
    b. Fuel reserve.

47. CLASS IIIA SUPPLY.
    a. Resupply.
    b. Fuel reserve.

48. CLASS V SUPPLY.
    a. Requisition method.
    b. Required forms and certificates.
    c. Basic load.
    d. Salvage.

49. VEHICLE AND EQUIPMENT MAINTENANCE.
    a. Maintenance category.
    b. Maintenance officer's responsibility.
    c. Required forms.
    d. Priorities.

50. REPAIR PARTS.
    a. Requisition method.
    b. Stock level maintenance.
    c. Maintenance inspections.
    d. Parts and equipment record.

51. VEHICLE AND EQUIPMENT EVACUATION CHANNELS.

/s/ ______________________________
Commander (name and rank)

Authentication:
Annexes: (May include Wearing of the Uniform, Reports Formats, Destruction of Classified Documents, Duties of Staff Officers, Staff Section SOPs, Loading Plans, Alert Plan).
Distribution:

Figure B-8. Transportation SOP format for units (continued)

(Classification)

Issuing unit
Place of issue (may be in code)
Date-time group of signature

File No. ________________
Embarkation Plan No. ________________
Maps: Those needed for understanding the plan.
References: SOPs, operation order, administrative order, and other relevant material.

1. ORGANIZATION FOR EMBARKATION
   a. Troop list for each embarkation group. May be issued as an annex.
   b. Embarkation schedule. Assignment of each embarkation group to shipping. Schedule shows berthing of ships and date and hour loading will begin. It also includes date and hour embarkation will be completed by each embarkation group. Other information pertinent to the embarkation schedule may be included. May be issued as an annex.
   c. Advance parties.
      (1) Composition.
      (2) Functions.
      (3) Movement to embarkation point. References to SOP if applicable.

2. SUPPLIES AND EQUIPMENT
   a. Amounts and types of supplies and equipment to be embarked.
   b. Preparation of supplies and equipment for embarkation. Reference may be made to appropriate SOP.
   c. Allocation of division supplies and equipment to cargo assembly areas. May be Issued as an annex with appendixes.

3. EMBARKATION POINTS AND CARGO ASSEMBLY AREAS
   a. Assignment of embarkation points and cargo assembly areas for loading. (May be a map, sketch, or overlay issued as an annex.)
   b. Preparation of embarkation points and cargo assembly areas for loading; construction to improve embarkation exits and facilities.
   c. Assignment of mechanical loading devices, such as forklift trucks, cranes, roller conveyors, warehouse pallets.

4. CONTROL
   a. Establishment and functions of embarkation control officer. Functions may be covered in SOP.
   b. Traffic circulation and control system in embarkation area and between embarkation area and base camp.
   c. Establishment of security posts for prevention of fire, sabotage, and pilferage in cargo assembly and deck areas.
   d. Communications for embarkation. References may be made to SIGNAL OPERATING INSTRUCTIONS.

Figure B-9. Division embarkation order format

5. PERSONNEL
   a. Schedule and method of movement from base camp.
   b. Schedule and instruction for embarkation.

6. MISCELLANEOUS
   a. Embarkation responsibilities and tasks. Responsibility of embarkation group commanders and tasks of officers. Supply officer, motor transport officer, unit movement officer, other.
   b. Special loading instructions. Stowage of certain types of cargo, handling of fragile or dangerous items, other.
   c. Miscellaneous instructions not covered elsewhere.

Acknowledgment instructions.

By Command of

/s/ ______________________
Chief of Staff

Authentication:
Annexes:
– Organization of Embarkation Groups – Assignments of Shipping.
– Supplies and Equipment to be Embarked.
– Embarkation Points and Cargo Assembly Areas.
– Others as necessary.
Distribution:

OFFICIAL ______________________
G3

Figure B-9. Division embarkation order format (continued)

TRANSPORTATION ESTIMATE

Transportation section (unit)

Location

Date-time group

References: Maps, charts, and other relevant documents.

1. MISSION. Mission of the command; mission of transportation units in support of the command's tactical and logistical mission. May be obtained from higher headquarters orders or deduced from instructions or knowledge of the situation; may be expressed in terms of personnel or tons of cargo to be transported, discharged, or outloaded.

Figure B-10. Transportation estimate format

2. SITUATION AND CONSIDERATIONS

a. Intelligence. Reference to pertinent intelligence estimate.

b. Tactical situation.

(1) Reference to current operation order.

(2) Present and planned disposition of major friendly tactical elements, with emphasis on those units defending lines of communication or transportation units and operations; effect of planned troop moves on transportation operations.

(3) All possible courses of action open to the command to accomplish the mission.

(4) Concept of projecting operations once the immediate mission is accomplished.

c. Logistics.

(1) Reference to current ADMIN/LOG order or overlay.

(2) Status of supplies and equipment in all transportation organizations of the command with any inadequacies highlighted.

(3) Any projected developments likely to affect the ability of transportation units to perform their mission from the logistical standpoint.

(4) Status of supplies and equipment in other logistical support units which might adversely affect accomplishment of the mission.

(5) All possible logistical courses of action and the effects of each on possible friendly tactical courses of action.

d. Personnel.

(1) Reference to current ADMIN/LOG order or overlay.

(2) Status of personnel in all transportation units, including morale and any other considerations likely to affect their performance.

(3) Status of personnel in other support units to be employed in logistical support of transportation operations that might adversely affect accomplishment of mission.

e. Assumptions. Logical assumptions may be made when there are not enough facts available to prepare the estimate.

f. Transportation. All known information, as detailed as possible, on each mode of transportation activity.

(1) Transportation activities. The format shown in (a) below should be modified as required for (b) through (j).

(a) Rail.

Unit	Strength Actual & Location	Facilities Actual & Auth	Equipment Required	Lacking	Capability Actual & Potential

(b) Motor.

(c) Inland waterway.

(d) Air.

(e) Water.

(f) Transportation movements.

(g) Staging areas.

(h) Pipelines (even though not operated by transportation units.)

(i) Troop carrier space.

(2) Transportation units courses of action. All courses of action open to transportation units for each possible logistical course of action set forth in paragraph c(5) above.

Figure B-10. Transportation estimate format (continued)

g. Special Factors. Any other factors that might influence the choice of a course of action or the ability to perform the mission, from both the transportation and overall mission standpoints.

3. ANALYSIS. A statement and analysis of the effects of each logistical course of action on each transportation activity.

a. Course of Action. Use the following format for each course of action mentioned in paragraph 2c(5).

Activity*	Effect on personnel	Effect on equipment	Effect on facilities	Effect on capabilities

b. Alternate Course of Action. Outline of alternate courses of action, if possible. Use same format as paragraph 3a.

4. COMPARISON

a. Dominant transportation factors and modes most likely to be used.

b. A comparison, based on the information in paragraph 3, of the various logistical courses of action, including their effects on each mode and its capabilities. The comparison will determine the most favorable course of action from a transportation standpoint.

c. Feasibility of the various lines of communications, ports, and beaches as affected by enemy capabilities, weather, terrain, et cetera.

5. CONCLUSIONS

a. Statement indicating whether the mission can be accomplished from the standpoint of transportation support.

b. Statement indicating which of the possible logistical courses of action can best be supported from the transportation standpoint.

c. Statement calling attention to any considerations required should alternate courses of action be chosen.

(1) Number and type of transportation units required over and above those available for each course of action if mission cannot be supported.

(2) Personnel and/or equipment shortages in existing units that would prevent mission accomplishment.

(3) Any repairs or construction work essential to successful mission accomplishment from the transportation standpoint.

(4) Any other transportation considerations which should be brought to the attention of the commander.

/s/ ______________________________

Transportation officer
(name and rank)

Authentication:
Annexes:
Distribution:

*Same as in paragraph 2f(1).

Figure B-10. Transportation estimate format (continued)

TRANSPORTATION PLAN NO ——[1]

Transportation section (unit)

Location

Date-time group of signature

Maps and references: Sheet name, number, scale, unit of measure, and series for each map. Other references include city plans, navigation charts, and other plans bearing on the transportation plan.

Task organization: Annex A, Task Organization.

1. SITUATION

a. Enemy Forces. All capabilities of the enemy to hinder, disrupt, or otherwise affect operations of transportation units and other elements of the command, including damage to lines of communications, and use of mass-destruction weapons (Annex B, Intelligence).

b. Friendly Forces. Units to be supported, their location and strength. Emphasis on units engaged in protection of lines of communication and transportation units or activities, including higher, adjacent, and supporting units of US and allied forces.

c. Area of Operations.

(1) Weather. Temperatures, wind conditions, rainfall, tide and river conditions, aeronautical weather information.

(2) Terrain and hydrography. Critical terrain features, signal operating instructions, soil trafficability, beach gradients, and any known obstacles; their possible effects on transportation modes.

(3) Lines of communication. All lines of communication and their physical condition.

d. Attachments and Detachments.

e. Assumptions and Policies. Any pertinent policies and logical assumptions needed to prepare the plan – proposed locations of major unit boundaries, troop strengths supported in different phases of the operation, et cetera.

2. MISSION. Mission of transportation units in support of the command.

3. EXECUTION

a. Commander's Intent.

b. Concept of Operation. The transportation officer's overall concept of the operation, including probable increases in supported units and additional territory to be supported. (Annex C, Concept of Operations).

c. Rail. Specific tasks assigned to rail units.[2]

d. Motor.

e. Air.

f. Water.

g. Inland Waterway.

h. Transportation Movements.

i. Staging Areas.

j. Pipelines (even though not operated by transportation units).

Figure B-11. Transportation plan format

k. Troop Carrier Space. Proposed use of air capacity allocated to the command.[2, 3] (As indicated in b above, similar information for each mode of transportation is best submitted as an annex, the format of which should parallel that of the plan itself as much as practical.)

l. Coordinating Instructions.

(1) Defense and security. Reference to appropriate SOP or defense plan.

(a) Individual.

(b) Facilities.

(c) Lines of communication.

(d) Shipments.

(e) Censorship.

(f) Communications.

(2) Counterintelligence. Annex B, Intelligence.

(3) Technical intelligence. Annex B, Intelligence.

(4) Effective time and date.

4. ADMINISTRATION AND LOGISTICS

a. Administration.

(1) Policies.

(2) Procedures. SOPs and related guides of higher headquarters not covered elsewhere in the plan.

(3) Required reports.

b. Logistics.

(1) Transportation supply. The following items are covered by reference to current SOPs when applicable.

(a) Levels of supply.

(b) Replacement factors and consumption rates.

(c) Requisition procedures and cycles.

(d) Emergency requisition procedures.

(e) Local procurement.

(f) Controlled items.

(g) Surplus material.

(h) Captured material.

(i) Salvage and scrap.

(j) Interservice supply.

(k) Class IV equipment.

(2) Equipment out of commission for parts procedures.

(3) Supply support of transportation mission by other services.

(4) Transportation maintenance. Maintenance facilities by mode, shop locations, and responsibilities of each maintenance unit.

c. Personnel.

(1) Policies.

(a) Local civilian personnel.

(b) Prisoners of war.

(c) US civilian personnel.

(2) Strengths.

Figure B-11. Transportation plan format (continued)

(3) Replacements.
(4) Procedures.

5. COMMAND AND SIGNAL
a. Command.
(1) Location of major command CPs.
(2) Location of transportation movements branches.
b. Annex D, Signal.

Acknowledgment instructions.

/s/ ____________________
Commander (name and rank)

Authentication:
Annexes:
Distribution:

---

[1] Any paragraph or subparagraph in the plan may consist wholly or in part of references to appropriate annexes. Annexes in turn may be simplified by referring to appendixes. Each transportation mode should have a separate annex.
[2] Projected loads, schedules, facilities, lines of communication, and similar information are best submitted as annexes to the plan.
[3] Transportation organizations do not assign tasks.

Figure B-11. Transportation plan format (continued)

Feasibility Test for Transportation Plan

1. GENERAL

a. This test is prepared to enable transportation staff planners to check the feasibility of a transportation plan (annex to administrative orders, letter of instructions, other) after the plan has been prepared.

b. The test has been prepared in checklist form. Paragraph 2 lists general considerations that apply to all modes of transportation; the remaining paragraphs list items that apply to a specific mode.

c. When using the checklist, consider the items listed in paragraph 2 in addition to the paragraph that applies to the particular mode.

2. GENERAL CHECKLIST ITEMS

a. Calculated risks. Calculated risks involved. Effect on the mission. Governing factors.

b. Weather and terrain. General considerations. Favorable or adverse effect on the mission.

c. Enemy action. Enemy guerrilla action, clandestine action, other.

d. Political and economic situation. Interference with local economy. Friendly or unfriendly attitude of the civilian population.

Figure B-12. Transportation plan feasibility test format

e. Transportation net. Integration of transportation net elements. Portions of the net reserved for civilian use. Emergency procedures for joint civil-military use. Engineer construction support of the present net and future operations.

f. Allocation and use of modes. Optimum use of transport capacity. Use of supporting service's capacities. Allocation to modes of tasks corresponding to their capabilities and equipment. Adequate provisions for retrograde cargo.

g. Logistical support. Support of modes in quantity and time to accomplish the mission (POL products, repair parts, and so forth).

h. Task organization.

(1) Clear definition of command relationships, missions, and functions.

(2) Troop list assignments.

(a) Strength.

(b) Training.

(c) Morale.

(d) Available transport equipment.

i. Local civilian and EPW labor. Availability in the skills required. Requirement for mobile civilian labor units for phase II and phase III operations. Adequate administrative and logistical support.

3. MOTOR TRANSPORT CHECKLIST

a. Requirements versus capabilities.

b. Traffic circulation plan.

(1) Road net support of planned traffic.

(2) Requirement for additional highway regulation personnel.

(3) Adequate road repair and road maintenance support.

(4) Designation of routes (restricted, dispatch, other).

(5) Possible joint use of road net. Can both combat forces (US and allied forces) and civilian traffic use it simultaneously?

(6) Availability of hardstand, maintenance areas, truck parks, relay stations, transfer points.

(7) Marked routes; availability of marking signs.

4. RAIL

a. Requirements versus capabilities.

b. Unusual weather or terrain factors.

(1) Are heavy rains due that may cause washouts, floods, or landslides?

(2) Is extreme subfreezing weather due?

c. Engineer maintenance and construction support for rehabilitation or for major repair of rail line.

d. Yards, roundhouse, repair shops.

e. Suitable water and fuel supplies (if steam locomotives are used).

f. Limiting factors.

(1) Bridge weight and clearance.

(2) Tunnel clearance.

(3) Roadbed and trackage.

(4) Rolling stock – condition, power, gauge.

(5) Locomotives – condition, power, gauge.

(6) Train operations communications.

5. INLAND WATERWAY

Figure B-12. Transportation plan feasibility test format (continued)

a. Requirements versus capabilities.
b. Weather and terrain. Freeze-up or flood period, tidal ranges, currents, fogs.
c. Obstructions. Low bridges, types of drawbridges. Natural obstructions, such as heavy weeds, that might foul propellers.
d. Locks. Locks controlled by assigned permanent personnel or the individual inland waterway craft. Size of locks; amount of time required to pass through.
e. Channels. Required maintenance. Size, depth, and width.
f. Navigational aids. Enough fixed or mobile navigational aids for full use, day and night.
g. Requirement for intermediate transfers.
h. Condition of available watercraft.
i. Marine repair and maintenance support.
j. Inland waterway facilities, docks, cranes.

6. PORTS AND BEACHES
a. Requirements versus capabilities.
b. Port facilities.
(1) Floating cranes for heavy lifts.
(2) Piers, docks, warehouses, open ground areas.
(3) Road nets and rail nets.
(4) Navigational aids.
(5) Protected anchorage areas.
(6) Utilities (electricity, other).
(7) Harbor craft.
(8) Berth space, lengths, and depths.
c. Beach facilities.
(1) Anchorage areas.
(2) Ingress and egress routes.
(3) Road nets and rail nets.
(4) Hardstand and open ground areas.
(5) Equipment (forklifts, cranes, other).
d. Weather and terrain.
(1) Ports.
(a) Tides and currents.
(b) Underwater obstructions.
(2) Beaches.
(a) Tides, currents, surf, gradient, tidal range.
(b) Underwater obstructions.

7. TRANSPORTATION MOVEMENTS
a. Sufficient teams to accomplish mission.
b. Adequacy (flexibility or rigidity) of transportation movements plan.
c. Location of teams for maximum use.
d. Documentation procedures.

8. STAGING AREAS

Figure B-12. Transportation plan feasibility test format (continued)

a. Capability of processing planned work loads.
b. Adequate facilities.

9. AIR
   a. Requirements versus capabilities.
   b. Marginal weather.
      (1) Low ceilings.
      (2) Low visibility.
      (3) Snow and ice.
      (4) Temperatures.
   c. Terrain. Altitudes (temperature and altitude affect lift capabilities).
   d. Navigational aids.
      (1) Possibility of day and night operations.
      (2) Ground stations.
         (a) Ground-controlled approach.
         (b) Radio range.
         (c) Instrument-landing systems.
         (d) Omnidirectional range (omni range).
         (e) Radar-plotting station.
      (3) Airborne navigational equipment.
   e. Communications. Adequacy of unit communications; augmentation required.
   f. Flight restrictions.
      (1) Maintenance of established air routes, including fire lanes.
      (2) Degree of air superiority.
      (3) Arrangements for weather reports from Air Force.
   g. Adequacy and location of landing sites or airfields; facilities at these locations.
   h. Maintenance.
      (1) Condition of aircraft (hours of previous operation).
      (2) Maintenance units available.
      (3) Repair parts available.
      (4) Location and stock of depot support.
   i. Degree of training of supported units in use of logistical air support.

10. FLEXIBILITY
   a. Provision for rerouting or diversion.
   b. Interchange points.
   c. Transfer points.
   d. Substitution of one mode for another.
   e. Capability of handling emergency transportation tasks.

Figure B-12. Transportation plan feasibility test format (continued)

APPENDIX C
TRANSPORTATION RELATED DATA

This appendix contains a variety of data that may be useful either in making computations or decisions related to daily or long-range planning. It includes odd pieces of information that are difficult to categorize or to find elsewhere.

CARGO DENSITY FACTORS

Most cargo cubes out before it weighs out. The following factors were developed to account for this condition.

Cargo Density by Supply Class

The data shown in Table C-1, page C-2, was obtained by analyzing military cargo records of medium truck companies. This information also applies when planning operations for other types of transportation units.

Weighted Mean Density by Supply Class

The data shown in Table C-2, page C-2, was obtained by analyzing actual shipment units. These data provide the weighting factors for computing weighted mean density. Weighted mean density of general noncontainerized cargo in common shipment unit configuration has been determined to be 16.08 pounds per cubic foot. Multiplying the density by the functional cube of a truck type determines the load the truck can carry.

MEAN CONTAINER CONTENT WEIGHT

Mean container content weight expresses truck unit container capability in tons as well as infinite numbers of containers. The data shown in Table C-3, page C-2, was obtained by analyzing thousands of military cargo container prime records. Applying this data, the two types of medium truck companies that transport containers were determined to have the TOE capabilities discussed in the paragraphs below.

Medium Truck Company (Cargo, EAC), TOE 55727L100

This company is equipped with commercial design tractors and semitrailers. Each semitrailer carries one 40-foot container or two 20-foot containers at a time. TOE capabilities are as follows–

- Line-haul. Consists of 105 40-foot containers or 210 20-foot containers per day (total weight per truck not to exceed 34 STONs). In tonnage terms, this translates to line-hauling 1,620 STONs of containerized general cargo or 2,920 STONs of containerized ammunition per day.
- Local haul. Consists of 210 40-foot containers or 420 20-foot containers per day (total weight per truck not to exceed 34 STONs). This translates to 3,240 STONs of containerized general cargo per day or 5,840 STONs of containerized ammunition per day.

Table C-1. Cargo density by supply class (in pounds per cubic foot)

CLASS	DENSITY lb/cu ft	CLASS	DENSITY lb/cu ft
I	11.29	VI	12.19
II	10.28	VII	10.21
III	18.45	VIII	6.15
IV	13.11	IX	12.91
V	19.72		

Table C-2. Determining weighted mean density

CLASS	CONSUMPTION lb/man/day	PERCENT DISTRIBUTION
I	6.72	4.98
II	3.17	2.35
III	0.59	0.44
IV	4.00	2.96
V	79.96	59.22
VI	3.40	2.52
VII	34.17	25.31
VIII	1.10	0.81
IX	1.91	1.41
Totals	135.02	100.00
Weighted Mean Density	16.08	

Medium Truck Company (Cargo, Corps), TOE 55728L100

This company is equipped with tactical design tractors and semitrailers. Each semitrailer carries one 20-foot container at a time. TOE capabilities are as follows–

- Line-haul. Consists of 102 20-foot containers per day (total weight per truck not to exceed 25 STONs). This translates to 658 STONs of containerized general cargo per day.
- Local haul. Consists of 203 20-foot containers per day (total weight per truck not to exceed 25 STONs). This translates to 1,315 STONs of containerized general cargo per day.

While ammunition is always transported in 20-foot containers, general cargo can be carried in either 20- or 40-foot containers. Also, general cargo containers frequently carry more than one supply class of cargo in a single container. Ammunition is never mixed with other commodities.

TASK VEHICLE AVAILABILITY RATE

The TVAR is defined as the average of the percentage of task vehicles available for mission accomplishment over time. Because TVARs are SRC-specific, they allow for a more accurate determination of truck unit capability based on the type of trucks in each unit. Elements that influence TVAR include:

- Task mission distance and duration.
- Vehicle reliability.
- Driver availability.
- Repair parts delay time.
- Mechanic availability.

The TVARs for each truck type/model are indicated in Table C-4, page C-3. These TVARs should be used when calculating resource requirements or truck capabilities.

Table C-3. Mean content weight in tons by container size

CONTENTS	CONTAINER SIZE 20-Foot	40-Foot
Ammunition	13.90	
General Cargo	6.47	15.42

SUPPLY

Transportation requirements result from supply requirements supporting sustainment operations in combat. Mode selection of transportation assets are directly effected by the quantity of supplies required, distances to be marched, and time required to meet demands.

Classes of Supply

The Army uses classes of supply to identify the different types of materials used for military operations. There are ten classes of supply. A general description of the type of material in each class is as follows:

- Class I – subsistence.
- Class II – clothing, individual equipment, tents, tools, and other supplies.
- Class III – petroleum, oil, lubricants, and fuel products.
- Class IV – construction/barrier material.
- Class V – ammunition.
- Class VI – personal demand (exchange) items.
- Class VII – major end items (tanks, vehicles, generators, radios, etc).
- Class VIII – medical supplies.
- Class IX – repair parts.
- Class X – material for nonmilitary programs.

Quantities

Based on a number of factors, the quantities of materials used by an Army force in combat operations will vary. These factors include:

- Climate and terrain in the area of operations.
- Intensity of combat.
- Size of the force.
- Distances to be traveled.
- Type and quantity of supplies available in the host country.

When the details of a combat operation are not known or rough resupply estimates are required, general pounds-per-man-per-day planning factors can be used for most classes of supply. To estimate resupply requirements, the planning factors listed in Table C-5, page C-4, should be multiplied by the number of men deployed.

Unit Weight for Shipment

For planning purposes, the weight in STONs of a unit is the sum of its combined weights. This total includes the following weights:

- TOE personnel and individual equipment, assuming an average weight of 240 pounds per man.
- Major items of organizational equipment.
- Class I supplies for three days, assuming 7.52 pounds per ration per man per day.
- Class III supplies necessary to move a unit 100 miles from the destination point after arrival, if authorized in shipment.
- Basic load of Class V.
- Added items that may be authorized by the theater or CONUS commander.

Table C-4. Task vehicle availability rates for the five truck types/models

TYPE UNIT	SRC	TASK VEHICLE	TVAR (Percent)
MED TRK CO EAC Cargo	55727L100	M915	87.5
MED TRK CO Corps Cargo	55728L100	M931	84.7
LT MED TRK CO Corps	55719L200	M923	85.9
LT MED TRK CO Corps	55719L200	M923A1	91.2
MED TRK CO PLS Corps Cargo	55728L300	PLS	90.5

Table C-5. Planning factors for estimating resupply requirements

CLASS OF SUPPLY	PLANNING FACTOR	SOURCE
Class I – A-RATION	2.549 lb/man/day	SB 10-260, FM 10-13
B-RATION	1.278 lb/man/day	SB 10-495
T-RATION	2.575 lb/man/day	NATICK PAM 30-2
MRE	1.570 lb/man/day	NATICK PAM 30-2
LRP(I)	1.250 lb/man/day	NATICK PAM 30-2
R/CW	2.750 lb/man/day	NATICK PAM 30-2
HCP1	.770 lb/man/day	NATICK PAM 30-2
HCP2	.055 lb/man/day	NATICK PAM 30-2
EXAMPLE RATION POLICY:		
1A + 1T + HCP1 + HCP2	= 7.52 lb/man/day (D-DAY to D+60)	
1A + 1T + _____ + _____	= 6.69 lb/man/day (after D + 60, AAFES in Theater)	
Class II –	3.17 lb/man/day	FM 101-10-1/2 (1987) (See * below for CDE)
Class III (packaged) –	.51 lb/man/day	SB 710-2, Jan 91
Class IV –	8.50 lb/man/day	FM 101-10-1/2 Made up of 4.0 barrier material & 4.5 base construction
Class VI – (After D+60)	2.06 lb/man/day (temperate) 3.40 lb/man/day (trop/arid)** 1.75 lb/man/day (arctic)**	AAFES Exchange Service Regulation- 8-4 Change 1, Mar 93

Class VIII (lb/man/day) –	INT	MOD	LIGHT	RES	SOURCE
Division	.65	.46	.28	.14	AMEDD Center and School (1992)
Non-Division	1.46	1.04	.63	.31	
Theater	1.55	1.10	.67	.33	

Water (gal/man/day) — FM 10-52 (1990)

	TEMPERATE	ARCTIC	TROPIC	ARID
Company	3.9	4.4	5.7	5.9
Battalion	6.6	7.2	8.5	8.7
Brigade	7.0	7.6	8.9	11.1
Division	7.0	7.6	8.9	11.9
Above division	7.8	8.4	9.9	18.4

* Per IDA Study on CDE, 1986-1988, add the following chemical defense equipment modifiers for:

NATO + 2.205 lb/man/day
NEA + 3.270 lb/man/day
SWA + 4.038 lb/man/day

CDE notes:

1. CDE consumption planning factors are for up to 30 days.
2. CDE consumption planning factors assume troops change chemical protective suit and chemical protective boots every 30 days unless mandated earlier by METT-T.

** Per AAFES Exchange Services Regulation 8-4, Emergency Operations, Appendix 8, Page AB-1, "For operations beyond D+180, add .03580 lb/man/day for supplemental stock assortments."

Planning Factor Data

The consumption factors listed in Table C-6 can be used for the type division shown and are considered valid for the MRC-East environment at the moderate level of combat. For the most current logistic planning factor data for all size units (battalion, brigade, division, or corps), contact:

Cdr, USACASCOM, Chief, Planning Factors Branch
ATTN: ATCL-FSP, Mr. Fitzjarrald or Mr. Blair
Fort Lee, VA 23801-6000
DSN 539-0639, FAX 539-0661

Class I (explosives) materials shall not be loaded, transported, or stored together, except as provided in this section, and in accordance with Table C-7, page C-6. For detailed shipment data on ammunition, contact:

HQ, US Army Armament Munitions and Chemical Command (AMCCOM)
Joint Munitions Transportation Coordinating Activity, AMSMC-TMJ-T
DSN: 793-4707/5408/6597, CML: 309-782-4707/5408/6597.

Questions about specific packaging information on ammunition should be addressed to:

HQ, AMCCOM, SMCAR-ESK,
DSN: 793-8204 or CML: 309-782-8204

NOTE: More than 14,000 packaging configurations are possible. Clearly, it is not practicable to provide even a partial list of those possibilities here.

Planning Terms

Planners should be familiar with terms commonly used in logistic planning. Definitions for some of the most frequently used terms are as follows:

- Consumption rate. The average quantity of an item consumed or expended during a given time interval, expressed in quantities per applicable basis.
- Day of supply. Quantity of supplies estimated to be required for one day under the conditions of the operation and for the force stated.
- Replacement factor. A number expressed as a decimal which, when multiplied by the total projected quantity of an item in use, gives the quantity of the item that needs to be replaced during a given period.
- Slice. An average logistical planning factor used to obtain estimates of requirements for personnel and material.

Storage

This section contains terms, definitions, and associated data useful to planners. When computing or selecting between long- or short-term storage, consider the following:

Gross storage area. See Table C-8, page C-7, for the average ratio of open-to-covered gross storage area by classes of supply.

Average stack height. The following figures are for average stack height. They can be used by all services in the theaters of operation.

- Covered storage – 8 feet (2.4 meters)
- Open storage – 6 feet (1.8 meters)

For CONUS storage, these figures must be increased by 25 percent.

Table C-6. Consumption factors

TYPE DIVISION	CLASS III	CLASS V	CLASS VII	CLASS IX
Armored (M1)	606,940 gal/day	1452 STONs/day	572 STONs/day	43 STONs/day
Infantry (Mech – M1/M2)	580,067 gal/day	1442 STONs/day	538 STONs/day	40 STONs/day
Light (LID)	69,488 gal/day	651 STONs/day	78 STONs/day	4 STONs/day
Airborne	102,783 gal/day	677 STONs/day	119 STONs/day	4 STONs/day
Air Assault	270,196 gal/day	847 STONs/day	198 STONs/day	6 STONs/day

Table C-7. Transportation compatibility table for Class I (explosives) material

COMPATIBILITY GROUP	A	B	C	D	E	F	G	H	J	K	L	N	S
A	X	X	X	X	X	X	X	X	X	X	X	X	
B	X		X	4	X	X	X	X	X	X	X	X	4/5
C	X	X		2	2	X	X	X	X	X	X	3	4/5
D	X	4	2		2	X	X	X	X	X	X	3	4/5
E	X	X	2	2		X	X	X	X	X	X	3	4/5
F	X	X	X	X	X		X	X	X	X	X	X	4/5
G	X	X	X	X	X	X		X	X	X	X	X	4/5
H	X	X	X	X	X	X	X		X	X	X	X	4/5
J	X	X	X	X	X	X	X	X		X	X	X	4/5
K	X	X	X	X	X	X	X	X	X		X	X	4/5
L	X	X	X	X	X	X	X	X	X	X	1	X	X
N	X	X	3	3	3	X	X	X	X	X	X		4/5
S	X	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	X	4/5	

(A) Instructions for using this table are as follows:

(1) A blank space in the table indicates that no restrictions apply.

(2) The letter "X" in the table indicates that explosives of different compatability groups may not be carried on the same transport vehicle.

(3) The numbers in the table mean the following:

(a) "1" means an explosive from compatibility group L shall only be carried on the same transport vehicle with an identical explosive.

(b) "2" means any combination of explosives from compatibility groups C, D, or E is assigned to compatibility group E.

(c) "3" means any combination of explosives from compatibility groups C, D, or E with those incompatibility group N is assigned to compatibility group D.

(d) "4" means §177.835 (g) when transporting detonators.

(e) "5" means Division 1.4S fireworks may not be loaded on the same transport vehicle with Division 1.1 or 1.2 (Class explosive) materials.

(B) Except as provided in paragraph (a) of this section, explosives of the same compatibility group but of different divisions may be transported together provided that the whole shipment is transported as though its entire contents were of the lower numerical division (i.e., Division 1.1 being lower than Division 1.2). For example, a mixed shipment of Division 1.2 (Class A explosive) materials and Division 1.4 (Class C explosive) materials, both of compatibility group D, must be transported as Division 1.2 (Class A explosive) materials.

(C) When Division 1.5 (blasting agent) materials, compatibility group D, are transported in the same freight container as Division 1.2 (Class A explosive) materials, compatibility group D, the shipment must be transported as Division 1.1 (Class A explosive) materials, compatibility group D.

Table C-8. Ratios of gross storage area by classes of supply

	RATIOS OF GROSS STORAGE AREA	
	Open	Covered
All classes (except bulk POL)	5.5	1
Classes I, II, III (packaged and solid), and IV	4.7	1
Class V (including 10% of V-A)	12	1

Ammunition. Ammunition storage per mile (1.6 km) of road is 1,000 short tons. Ammunition storage per square mile is 5,000 short tons. Table C-9 contains dimensions for packaged missiles and other special ammunition.

Vehicles. The minimum hardstand for 2,500 vehicles is 110,000 square feet. Solid footing for a vehicle park for 2,500 vehicles is 4,000,000 square feet. Minimum hardstand for artillery and combat vehicles per item is 350 square feet.

Containerized and bulk cargo. Table C-10, page C-8, gives the dimensions of drums, cans, and pails. Table C-11, page C-8, shows bulk cargo capacity.

Table C-9. Packaged missiles and other special ammunition

WEAPON	CONTAINER AND CONTENTS	CONTAINER DIMENSIONS Length (in)	Width (in)	Height (in)	VOLUME (cu ft)	GROSS WEIGHT (lb)	REMARKS
Hawk	Complete round	216.00	28.75	41.50	150.7	3,351	
Redeye	Three complete rounds	56.40	15.00	12.50	6.1	144	Shipping & storage container, GM System XM547 (tripak)
Redeye	Unipack, one round	56.50	10.00	15.50	5.1	50	
Shillelagh	Complete round	52.50	14.75	14.75	6.8	116	metal container
Chaparral	Complete round	12.50	18.00	19.00	24.7	280	
Hellfire	Complete round	76.20	15.50	16.50	11.3	185	
Tow	Complete round	58.25	11.67	11.67	4.5	87	
Dragon	Complete round	47.50	16.00	16.00	7.0	67	
Stinger	Complete round	67.25	13.13	10.50	5.3	77	
ATACMS		166.00	41.50	33.00	131.5	4,814	one round per container
MLRS	Six-round pod	166.00	41.50	33.00	131.5	5,078	six-round shipping & firing configuration
Patriot	Complete round	234.00	42.38	38.75	231.4	3,750	typical stack has two rounds

Table C-10. Dimensions of containers

NOMENCLATURE	UNITS PER PACKAGE	TYPE OF PACKAGE	SIZE OF PACKAGE Width or Length (in)	Diameter (in)	Height (in)
Drum					
US 55-gal, 16 gauge	1	drum	0	23 7/16	35
US 55-gal, 18 gauge	1	drum	0	23 7/16	35
Can					
US 5 gal (fuel)	1	can	13.75	6.75	18.5
US 5 gal (oil)	2	case	—	11 15/16	14 13/16
US 5 qt (oil)	6	case	—	14.0	10.0
US 1 qt (oil)	24	case	16.375	12 3/16	11.625
Pail					
US 35 lb	1	pail	0	11.5	13 9/16

NOTE: Source document is FM 10-69, Appendix A.

Table C-11. Bulk capacities

CARRIER	CAPACITY (gal)	JP-8 (STONs)
Pipeline[1]		
6 inch	719,880 per day[2]	3,500
Railroad		
tank car	8,000; 10,000; 12,000	24.1; 30.6; 36.8
Semitrailer, 12 ton, 4W	5,000	15.3
Tank, portable fabric[3]	10,000	30.6

[1] In maintaining the same volumetric pipeline capacity for gasoline and oil, more pressure is required for the heavier liquid.

[2] Based on 6-inch IPDS (inland petroleum distribution system), 35,994 per hour for 20 hours of operation. In an emergency it can deliver 48,006 gallons per hour for 24 hours of operation or 1,152,144 gallons per day.

[3] When full, 40 feet long, 12 feet wide, 3 feet high. When empty, it can be rolled to 20 inches by 12 feet; 10 can be carried in a 6 x 6 truck.

Tentage. Table C-12, page C-10, lists the types of tents, their dimensions, and ground perimeter. Table C-13, page C-11, lists the types of tents and total weight. For updated tent information (weight and cubes of items in question), check the AMDF packaging section. If the data you need is not available, please contact the following:

Defense Personnel Support Center
2800 South 20th Street
Philadelphia, PA 19101-8419

(To receive assistance, you must have an NSN. Nomenclature alone is not sufficient).

NONTRADITIONAL TRANSPORTATION MODES

Army special operations are conducted throughout the world in all climatic and terrain conditions. Alternate methods of transportation must be used to meet mission requirements. They include use of the following.

Dogs

Trained dogs may be used individually or in teams to transport cargo in arctic areas. They also have limited use in temperate zones to carry messages and small packages of mail, usually in regions inaccessible to other means of transport. Dogs should be permitted to rest 10 minutes in each hour and should not be worked continuously for more than 16 hours per day. For planning purposes, towed loads should not exceed 100 pounds per dog, although the heavier breeds are capable of loads of 200 pounds per dog on a flat surface with good traction.

The Eskimo dog, or husky, is most commonly used in arctic and subarctic regions – the German Shepherd in temperate zones. On packed snow with good traction, an individual dog in a sled team has the cargo-carrying capabilities shown in Table C-14, page C-12, for carrying cargo packs, messages, and mail. These figures are under normal operating conditions and vary widely under extremes of weather and terrain. Table C-15, page C-12, shows the carrying capacities of pack dogs over various terrain On hard surfaces with good traction, an individual dog has the capabilities shown in Table C-15 for carrying cargo packs, messages, and mail.

Pack Mule

Pack mules are normally 59 to 62 inches tall and weigh 1,000 to 1,200 pounds. They travel at a rate of 3.5 to 4 miles (5.6 to 6.4 kilometers) per hour. Pack mules can carry from 200 to 250 pounds in equipment or supplies or transport two litter or two sitting casualties.

They can travel an average daily distance of 12 miles (19 kilometers) in mountainous terrain and 24 miles (39 kilometers) in rolling or flat terrain. Pack mules ascend at the rate of 1,650 vertical feet (503 meters) per hour. They are noneffective approximately 3.2 percent of the time.

Pack mules need 10 pounds of oats and 14 pounds of hay per day. These amounts may be reduced for short periods up to 10 days without impairing capability. Also, pack mules must have at least 10 gallons of water per day. For criteria for transporting pack mules, see Table C-16, page C-12. Horse- or mule-drawn carts are capable of traveling 20 miles (32 kilometers) per day drawing a payload of 1,000 pounds.

Human Bearers

Males can carry an average cargo load of 80 pounds. Females can carry an average cargo load of 30 to 35 pounds. Each litter team consists of 8 to 12 humans.

For average conditions on level terrain, teams can march an average of 12 miles per day. To estimate the time needed to cover a given distance in hilly or mountainous areas, use the following equation. (For these conditions, cargo loads given above for males and females should be reduced from 20 to 30 percent, depending upon the steepness of the terrain.)

$$T = t + a + d$$

where:

T = total time required

t = time required to march a given map distance

$$a = \frac{\text{total ascent in feet during march}}{1{,}000}$$

$$d = \frac{\text{total descent in feet during march}}{1{,}500}$$

Tactics such as overloading or speeding up operations can increase the sick rate and cause desertion. Human bearers are noneffective about 30 percent of the time and must be closely supervised to prevent pilferage.

COLD WEATHER OPERATIONS

Soldiers must be able to conduct military operations for extended periods of time under the most severe and varying cold weather climatic conditions. Troops properly trained in the following will be able to perform in any cold weather area of the world. The weather conditions in extremely cold areas make operations for friendly and enemy forces difficult. These conditions can also directly effect equipment operations capability.

Table C-12. Tentage data (dimensions and ground perimeter)

TYPE	SIZE					
			HEIGHT			
	FLOOR DIMENSIONS (in)	GROUND PERIMETER (in)	Ridge (in)	Side Wall (in)	SURFACE AREA (sq ft)	FLOOR SPACE (sq ft)
Tents						
Arctic, 10-man	210 dia	630	102	36	316	199
Assembly	480 x 960	2,467	252	96	4,965	2,857
Balloon, inflation	159 x 182	682	148	[1]	885	201
CP, M1942	84 x 142	452	84	72	328	84
CP, M1945	120 x 247[2]	627	108	66	406	172[2]
Fly, squad	240 x 251	1,382	144	63	1,673	750
Fly, ward, hosp	240 x 648	1,776	144	63	2,216	1,080
GP, large	216 x 624	1,680	144	66	2,035	936
GP, medium	192 x 396	1,176	120	66	915	528
Hexagonal, M1950	159 dia	477	102	24	218	113
Hospital, sectional	216 x 636[3]	1,704	144	72	2,170	954[3]
Hospital, ward	192 x 600	1,584	144	54	2,162	800
Kitchen	144 x 216	720	144[4]	72	831	216
Maint, shelter	218 x 322	1,080	164	66	1,306	487
Mountain	54 x 82	272	43	12	112	31
Op, surgical	192 x 324	1,032	144	84	1,190	432
Op. surgical, hv	216 x 648	1,728	133	72	2,068	972
Pyramidal	192 x 192	768	144	63	896	256
Pyramidal, lightweight	132 dia	414	102	24	182	95
Squad, M1942	192 x 384	1,152	144	54	886	512
Squad, M1945	192 x 384	1,152	144	54	886	512
Storage	214 x 241	910	156	63	1,008	358
Wall, large	168 x 174	684	132	54	570	203
Wall, small	106 x 110	432	102	45	284	81
Paulins[5]						
Fly, storage	300 x 245				512	
Fly, wall, small	186 x 110				142	
Large	240 x 480				800	
Medium	192 x 384				512	
Screen, latrine	216 x 108 x 84[6]	660		72[7]	292	144
Small	144 x 204				204	

[1] Arched top.

[2] The two measurements shown are the longest dimensions, including vestibule (trapezoid measuring 120 x 48 x 89.5 x 89.5 inches).

[3] Does not include vestibules at each end, which measure 48 x 90 inches.

[4] Height shown is for stack section. Service section is 108 inches high.

[5] Dimensions shown for flys and paulins are length and width.

[6] Screen has a 3-foot overlap on one side for an entrance.

[7] Bottom edge of screen normally 9 inches off ground.

Table C-13. Tentage data (weight)

TYPE	WEIGHT (LB) Tent Only	WEIGHT (LB) Pins, Poles	TOTAL WEIGHT (lb)	BULK STORAGE Tent Only (cu ft)	BULK STORAGE Pins, Poles (cu ft)	TOTAL CUBE PACKED (cu ft)
Tents						
Arctic, 10-man	68	8	76	7.1	0.2	7.3
Assembly	1,100	655	1,755	23.3	16.9	40.2
Balloon, inflation	110	333	443	6.3	3.6	9.9
CP, M1942	112	104	216	4.3	5.0	9.3
CP, M1945	165	92	257	7.6	4.5	12.1
Fly, squad	190	62	252	21.0	7.7	69.0[1]
Fly, ward, hosp	225	101	326	12.7	6.3	19.0[2]
GP, large	420	245	665[3]	3.6	0.2	3.8
GP, medium	255	200	455[2]			
Hexagonal, M1950	40	8	48	31.5	12.2	43.7
Hospital, sectional	770	327	1,097			
Hospital, ward	390	259	649	20.5	9.6	30.1
Kitchen	203	217	420	14.2	12.0	26.2
Maint, shelter	500	755	1,255			
Mountain	6	4	10	26.3	58.0	84.3
Op, surgical	252	75	327	0.5	0.2	0.7
Op, surgical, hv	817	876	1,693			
Pyramidal	130	94	224	10.3	3.5	13.8
Pyramidal,	37	2	39	38.8	23.2	62.0
lightweight				6.2	3.6	9.8
Squad, M1942	255	147	402	2.5	0.2	2.7
Squad, M1945	275	150	425	10.9	5.9	16.8
Storage	200	202	402	11.1	6.1	17.2
Wall, large	130	145	275	9.6	9.2	18.8
Wall, small	55	60	115	5.8	3.1	8.9
Paulins						
Fly, storage	85	20	105	3.4	4.1	7.5
Fly, wall, small	23	15	38			
Large	250		250	2.8	0.8	3.6
Medium	160		160	3.1	0.7	3.8
Screen, latrine	32		32	6.7		6.7
Small	57		57	4.2		4.2

[1] Bed patients on cots.

[2] Liner weighs additional 90 pounds and occupies a stored cubage of 8 cubic feet.

[3] Liner weighs an additional 155 pounds.

Table C-14. Cargo-carrying capabilities of sled dogs

TERRAIN	LOAD PER DOG [1] OR (lb)	DISTANCE PER HOUR [2] (KM)	(MI)
Flat	50	9.6	6
Hilly	50	4.8	3
Mountainous	50	1.6	1

[1] Includes weight of sled
[2] Reduce 50 percent when load is doubled

Table C-15. Carrying capacities of pack dogs

	LOAD PER DOG		DISTANCE PER HOUR			
TERRAIN	Cargo Pack (lb)	Messages or Mail	Cargo Pack (km)	(mi)	Messages or Mail (km)	(mi)
Flat	35	5 percent	3.2	2	24	15
Hilly	30	of dog's	3.2	2	16	10
Mountainous	25	weight	1.6	1	8	5

Table C-16. Criteria for transporting pack mules

VEHICLE	CAPACITY (Horses or Mules)
Trailer, 2-horse van	2
Truck, 1½-ton, cargo	2
Truck, 2½-ton, cargo	4
Semitrailer, 6-ton, combination animal and cargo	8
Railroad stock car, 40-foot	Approx 25
Railroad stock car, 36-foot	Approx 20 to 25
Airplane, cago transport	4 to 6[1]

[1] May be transported at altitudes up to 18,000 feet with no ill effects.

Fuel Consumption Rates

For heating, coal stoves need about 20 pounds of coal per day for summer operations (temperatures 10^0 F or above) and approximately 50 pounds of coal per day for winter operations (temperatures below 10^0 F). For cooking, coal stoves require approximately 50 pounds of coal per day.

In continuous operations, a 5-kilowatt generator burns about 20 gallons of gasoline per day. A 30-kilowatt generator burns approximately 30 gallons of diesel fuel oil (VVF 800) per day. A 45-kilowatt generator burns approximately 35 gallons of diesel fuel oil (VVF 800) per day.

A Yukon stove burns 5 gallons of gasoline in a 10- to 12-hour period while heating the 10-man arctic tent in temperatures of 0^0 F and lower. This stove also burns wood or coal.

To start motors and pumps, 0.2 gallon of gasoline is required. This figure is based on an average of 1 hour of operation per day.

Oil/Lubrication Consumption Rates

Large, general-purpose tractors use about 2 gallons of engine oil per day. The rate is considered equal for OE 30-10-5. The consumption rate for a light vehicle is 0.006 gallon per mile.

The rate of gear oil consumption is 0.45 gallon per mile for a large, general-purpose tractor; 0.006 gallon per mile for a light vehicle.

GAA is used as an all-purpose grease (also used for water pumps and so forth). The consumption rate is 0.005 pound per mile. Consumption rates for generators and for starting motors and pumps are based on the data shown above for those items.

Initial antifreeze will be added to all vehicles embarking on a cold-weather operation. Refer to Table C-17 to prepare antifreeze solutions.

Table C-17. Guide for preparation of antifreeze solutions

LOWEST EXPECTED AMBIENT TEMPERATURE (°F)	ARCTIC GRADE ANTIFREEZE (-90° F) (MIL-C-11755)	ETHYLENE-GLYCOL ANTIFREEZE (-60°F) (SPEC O-E-771A, TYPE 1)		DENATURED ALCOHOL (GRADE III) [2] PINTS PER GALLON OF COOLANT CAPACITY [1]
		Pints Per Gallon of Coolant Capacity [1]	Specific Gravity (68° F)	
+20	Freezing point of -90° F	1 1/2	1.002	1 1/2
+10		2	1.036	2 1/4
0	Issued ready for use and must not be mixed with any other liquid.	2 3/4	1.047	2 3/4
-10		3 1/4	1.055	3 1/4
-20		3 1/2	1.062	3 1/2
-30		4	1.067	4 1/2
-40		4 1/4	1.073	5
-50		4 1/2		
-60		4 3/4		

[1] Includes heaters and so forth.

[2] Used as temporary emergency expedient when neither arctic grade antifreeze nor ethylene-glycol antifreeze is available.

CAUTION

Do not use ethylene glycol full strength. It will freeze at a higher temperature than ethylene-glycol mixed with water.

Batteries

The electrolyte in acid-type storage batteries is usually composed of sulfuric acid and pure water. The proportion of these two substances determines the specific gravity of the electrolyte. In turn, the specific gravity determines the state of charge of the battery. When the battery discharges, water is formed, causing a reduction in specific gravity. When the battery charges, sulfuric acid is formed, causing an increase in specific gravity. When the ratio of water to acid is 1.275 to 1.300 at 80^0 F, the battery is fully charged. The proportions of acid to water shown in Table C-18 are used to make electrolytes of various specific gravities at 80^0 F. Freezing points of the resulting electrolytes are also shown.

Arctic and subarctic temperatures adversely affect the performance of storage batteries. At -30^0 F, the available energy from a battery is only about 10 percent of what it would be at 80^0 F. For efficient operation, battery temperatures should be kept from dropping below +30^0 F. This can be accomplished by using winterization kits. Also, the specific gravity must be kept in the 1.275 to 1.300 range, when corrected to a temperature of +80^0 F. Specific gravity changes about .002 for each 5-degree temperature change below or above 80 degrees. Specific gravities and approximate states of charge for various temperatures are given in Table C-19, page C-15.

Power Vehicles and Sleds

Specifications for power vehicles and sleds used in cold weather operations are shown in Figure C-1, page C-15.

Ice

Factors that affect the strength of ice include its structure, purity of the water from which it is formed, its cycle of formation (freezing, thawing, and refreezing), temperature, snow cover, and underlying water currents. Also significant is whether or not the ice is water-supported.

Although the sustaining capacity of ice cannot be determined accurately, experience and tests provide the working capacity figures for good quality freshwater ice (Table C-20, page C-16).

Table C-18. Proportions of acid to water/used to make electrolytes

PARTS CONCENTRATED SULFURIC ACID TO ONE PART OF WATER			
By Volume	By Weight	SPECIFIC GRAVITY	APPROXIMATE FREEZING POINT (°F)
0.232	0.416	1.200	-16
0.250	0.545	1.210	-25
0.294	0.527	1.240	-51
0.364	0.667	1.280	-90

Table C-19. Specific gravities and approximate states of charge

TEMPERATURE (°F)	SPECIFIC GRAVITY	APPROXIMATE STATE OF CHARGE (Percent)	TEMPERATURE (°F)	SPECIFIC GRAVITY	APPROXIMATE STATE OF CHARGE (Percent)
-80	1.000 (water)	Fully discharged	-20	1.235-1.260	65
-80	1.130	Discharged	-15	1.237-1.262	68
-75	1.213-1.238	46	-10	1.239-1.264	70
-70	1.215-1.240	48	-5	1.241-1.266	73
-65	1.217-1.242	50	0	1.243-1.268	75
-60	1.219-1.244	52	+5	1.245-1.268	77
-55	1.221-1.246	54	+10	1.247-1.270	79
-50	1.223-1.248	56	+15	1.249-1.272	80
-45	1.225-1,250	58	+20	1.251-1.274	82
-40	1.227-1.252	60	+25	1.253-1.278	84
-35	1.229-1.254	62	+30	1.255-1.280	85
-30	1.231-1.256	63	+80	1.275-1.300	100
-25	1.233-1.258	64			

POWER VEHICLE TYPE – M973, 1 1/2-ton

GROSS WEIGHT
- Front car – 7,200 lb
- Rear car – 6,800 lb
- Total – 14,000 lb

SPEED
- Road – 31 mph
- Water – 2.2 mph

CRUISING RANGE ON ROADS – 200 mi

ARTICULATED TURNING RADIUS – 23 ft

MAXIMUM PAYLOAD
- Front car – 1,100 lb
- Rear car – 3,100 lb
- Total – 4,200 lb

FORWARD GRADEABILITY
- Hard surface – 60°
- Snow (32 in) – 30°

CARGO SPACE
- Front car – 88 cu ft
- Rear car – 194 cu ft
- Total – 282 cu ft

ENGINE
- Four stroke in line, 5 cylinder, diesel
  - NOTE: M973A1 is a four stroke, 6 cylinder diesel

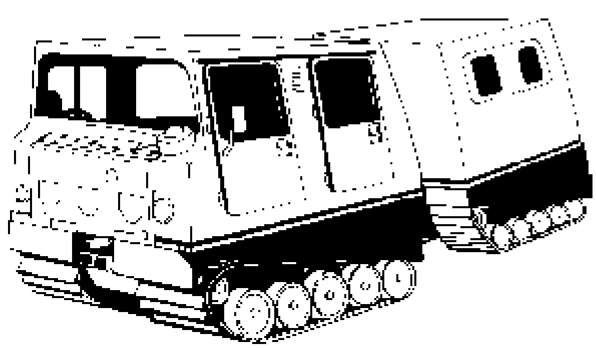


Figure C-1. Power vehicle and sled specifications

Table C-20. Load-bearing capacity of waterborne freshwater ice [1]

LOAD	ICE THICKNESS (in)	DISTANCE BETWEEN UNITS (ft)
File of soldiers (2-pace interval)	3	
Vehicle class		
1	4	60
2	6	70
4	8	80
6	10	90
8	11.5	100
10	13	110
15	15.5	125
20	18	135
25	20	150
30	22	165
40	25	180
50	28	195
60	31	205

[1] Double figures for old sea ice and triple for young sea ice.

Temperature, Snow Cover, and Precipitation

The temperature charts in Table C-21, page C-17, and Table C-22, page C-18, may be used as a guide for preliminary planning of operations in the areas shown. The precipitation charts in Table C-23, page C-19, may also be used for preliminary planning of operations. Keep in mind that seasonal storms, may cause some of the figures to vary for short periods. Planners should obtain further information about specific areas. Also, they should include appropriate safety factors into planning for individual clothing, winterizing equipment, and so forth.

Temperatures in the chart are not averages, but are the high and low extremes for each month for each area shown. The figures showing snow cover indicate expected snow depths since packing and partial melting reduce residual quantities.

Mean annual precipitation includes snowfall and rain, with the total represented as inches of water (10 inches of snowfall equals 1 inch of water). Generally, most precipitation above 70^0 latitude is snow. However, this rule should be used with discretion. Other factors (longitude, sea currents, air currents, and so forth) also affect the type and quantity of precipitation.

Windchill

The wind-chill factor is the temperature of windless air that would have the same effect on the exposed human skin as a given combination of wind speed and air temperature. See Table C-24, page C-20, for wind-chill factors.

Table C-21. Temperature values for arctic and subarctic areas (January through June)

	LOCATION	NORTH LATITUDE Deg	NORTH LATITUDE Min	TEMPERATURE EXTREMES, °F JANUARY Low	JANUARY High	FEBRUARY Low	FEBRUARY High	MARCH Low	MARCH High	APRIL Low	APRIL High	MAY Low	MAY High	JUNE Low	JUNE High
Alaska	Anchorage	61	10	-40	49	-45	49	-25	54	0	64	20	84	35	84
	Aniak	61	35	-65	49	-60	49	-45	54	-30	59	-5	74	30	84
	Barrow	71	18	-55	29	-55	24	-45	29	-35	34	-15	39	15	64
	Barter Island	70	7	-50	34	-60	24	-40	34	-40	34	-15	44	20	64
	Big Delta	64	0	-60	49	-60	49	-40	54	-20	69	15	89	20	89
	Cordova	60	30	-25	49	-35	49	-15	59	5	64	20	79	30	79
	Fairbanks	64	49	-60	39	-60	44	-40	54	-20	69	15	89	30	94
	Galena	64	43	-60	39	-60	39	-45	54	-30	64	-5	84	30	89
	Kotzebue	66	52	-45	34	-50	39	-40	34	-25	44	-20	74	20	84
	Nome	64	30	-45	39	-50	54	-40	44	-25	54	-15	69	25	79
	Umiat	69	22	-60	34	-60	29	-55	39	-50	59	-25	59	20	74
	Wales	65	37	-35	34	-40	44	-35	39	-25	44	-5	59	20	64
	Wiseman	67	26	-60	39	-60	34	-40	39	-30	49	-5	79	30	84
Canada	Aklavic	68	14	-50	29	-60	44	-40	44	-35	59	-15	74	20	84
	Alert	82	30	-55	9	-50	14	-50	9	-40	29	-15	44	15	59
	Arctic Bay	73	0	-45	24	-55	34	-50	24	-40	29	-10	39	15	59
	Baker Lake	64	18	-50	-1	-50	14	-30	19	-35	34	-15	39	15	59
	Cambridge Bay	69	7	-55	19	-55	14	-45	19	-40	24	-15	44	15	64
	Chesterfield	63	20	-50	34	-55	29	-50	29	-40	39	-20	44	10	74
	Clyde	70	27	-40	14	-45	24	-45	24	-30	19	-10	39	20	44
	Coppermine	67	49	-55	14	-55	29	-45	29	-35	39	-15	64	15	84
	Coral Harbor	64	12	-55	9	-55	29	-35	24	-35	29	-15	39	20	54
	Dawson	64	4	-60	39	-60	49	-35	49	-40	64	10	84	25	89
	Eureka	80	0	-60	24	-60	1	-60	9	-50	29	-20	44	10	59
	Fort Providence	61	20	-60	29	-55	24	-40	54	-25	64	10	74	25	89
	Fort Smith	61	1	-50	44	-60	54	-40	49	10	84	-35	79	25	89
	Frobisher Bay	63	45	-53	44	-50	39	-45	39	-30	39	-15	54	15	69
	Holman Island	70	30	-45	9	-45	19	-35	19	-25	39	-5	39	20	69
	Isachsen	78	47	-60	19	-60	-6	-60	9	-40	29	-15	34	10	54
	Mould Bay	76	14	-60	9	-55	-1	-55	14	-40	29	-15	34	10	59
	Norman Weils	65	17	-50	24	-60	24	-30	49	-15	59	10	74	30	89
	Nueltin Lake	60	30	-50	19	-55	19	-40	39	-35	49	-10	69	25	74
	Padloping Island	67	6	-50	29	-50	24	-45	29	-25	44	-15	49	15	59
	Resolute	74	43	-55	24	-55	9	-55	19	-35	29	-15	39	10	59
	Snag	62	22	-60	34	-60	44	-40	54	-50	59	0	89	25	89
	Watson Lake	60	7	-60	44	-60	44	-40	49	-20	59	20	84	25	84
	Whitehorse	60	43	-60	44	-60	49	-25	49	-15	59	20	84	25	84
	Yellowknife	62	28	-60	39	-60	34	-40	39	-25	64	0	69	30	84
Greenland	Angmagssalik	65	37	-5	39	-10	39	-5	49	0	54	15	54	30	59
	Daneborg	74	18	-25	29	-35	19	-35	24	-20	29	0	49	25	54
	Dammarkshavn	76	46	-45	34	-40	34	-30	19	-30	29	-5	39	15	59
	Godhavn	69	15	-20	39	-20	44	-15	44	-15	49	10	59	25	64
	Godthaab	64	10	-10	44	-5	44	-5	39	5	54	25	64	30	69
	Inglefield Bay	77	25	-40	34	-40	29	-40	29	-25	39	10	44	20	49
	Julianehaab	60	43	-15	59	-20	49	0	49	5	59	20	64	25	64
	Kap Tobin	70	25	-40	29	-45	34	-30	29	-15	34	5	44	25	49
	Narssarssuaq	61	11	-30	54	-30	59	-15	59	-5	64	15	69	30	74
	Sondre Stromfjord	67	0	-50	49	-50	54	-45	54	-20	59	-5	69	25	74
	Thule	76	31	-40	39	-45	34	-40	24	-30	44	-5	49	20	59
	Tingmiarmint	62	32	-5	39	-10	39	0	44	0	44	15	49	30	54
	Upernavic	72	47	-25	49	-30	49	-30	44	-20	44	0	54	20	59
Iceland	Reykjavic	64	8	0	54	5	54	5	49	15	59	15	64	30	64
	Seydisfjord	65	16	-5	64	-5	59	5	74	15	64	20	74	10	79

Table C-22. Temperature values for arctic and subarctic areas (July through December)

LOCATION		NORTH LATITUDE Deg	Min	TEMPERATURE EXTREMES, °F JULY Low	High	AUGUST Low	High	SEPTEMBER Low	High	OCTOBER Low	High	NOVEMBER Low	High	DECEMBER Low	High
Alaska	Anchorage	61	10	40	84	30	84	20	74	0	64	-20	54	-35	44
	Aniak	61	35	30	94	20	84	10	69	-20	64	-40	54	-55	44
	Barrow	71	18	25	74	20	74	5	64	-15	44	-40	39	-50	29
	Barter Island	70	7	25	74	25	64	5	64	-20	44	-55	39	-50	34
	Big Delta	64	0	35	94	20	84	5	74	-20	59	-45	54	-60	39
	Cordova	60	30	35	84	30	79	20	69	15	74	-15	54	-20	49
	Fairbanks	64	49	35	94	20	84	10	74	-15	64	-40	49	-60	34
	Galena	64	43	40	89	30	84	15	69	-15	59	-50	44	-60	39
	Kotzebue	66	52	30	84	30	79	15	74	-10	54	-35	39	-45	34
	Nome	64	30	30	74	25	74	15	64	-5	59	-40	44	-45	39
	Umiat	69	22	30	89	20	79	-5	64	-30	49	-55	44	-60	34
	Wales	65	37	35	69	30	74	25	54	10	49	-15	44	-30	34
	Wiseman	67	26	35	89	25	79	5	59	-25	44	-45	34	-55	29
Canada	Aklavic	68	14	35	84	30	79	15	69	-15	59	-40	39	-55	39
	Alert	82	30	25	69	5	54	-15	44	-30	19	-40	24	-50	9
	Arctic Bay	73	0	30	64	30	59	10	49	-15	34	-40	34	-40	14
	Baker Lake	64	18	30	74	30	69	15	49	-10	39	-30	29	-40	19
	Cambridge Bay	69	7	30	69	25	64	10	54	-20	39	-40	24	-50	19
	Chesterfield	63	20	30	84	30	74	15	59	-10	49	-35	39	-50	24
	Clyde	70	27	25	59	25	59	20	44	-5	34	-20	34	-40	19
	Coppermine	67	49	30	84	30	79	15	69	-25	59	-40	34	-40	24
	Coral Harbor	64	12	30	79	25	69	10	49	-10	34	-35	34	-50	29
	Dawson	64	4	35	94	25	84	15	74	-5	64	-50	49	-60	44
	Eureka	80	0	30	69	15	59	-15	39	-45	29	-50	29	-60	14
	Fort Providence	61	20	35	89	25	94	5	79	10	14	-40	49	-60	49
	Fort Smith	61	1	35	99	25	94	15	84	-5	74	-35	44	-55	44
	Frobisher Bay	63	45	30	79	20	74	15	59	-5	44	-35	29	-35	34
	Holman Island	70	30	30	74	25	64	10	44	0	34	-25	19	-30	9
	Isachsen	78	47	25	64	10	59	-10	34	-30	29	-45	19	-55	14
	Mould Bay	76	14	25	59	15	59	-15	39	-25	29	-45	24	-60	14
	Norman Weils	65	17	35	89	30	89	5	69	-5	49	-35	24	-55	14
	Nueltin Lake	60	30	40	84	35	79	15	69	-20	54	-30	39	-40	24
	Padloping Island	67	6	25	74	25	64	5	64	5	59	-35	44	-40	34
	Resolute	74	43	30	64	15	59	0	44	-25	34	-40	29	-55	19
	Snag	62	22	30	84	25	79	-5	74	-20	59	-55	34	-60	34
	Watson Lake	60	7	35	89	20	84	20	79	-20	69	-40	49	-60	39
	Whitehorse	60	43	30	84	20	84	15	79	5	59	-45	49	-55	49
	Yellowknife	62	28	40	89	35	89	20	69	0	64	-30	39	-50	39
Greenland	Angmagssalik	65	37	30	74	30	64	25	64	15	49	0	54	-10	44
	Daneborg	74	18	30	54	25	59	10	44	-15	34	-25	24	-20	14
	Dammarkshavn	76	46	25	59	20	54	5	44	-20	29	-30	29	-35	19
	Godhavn	69	15	35	64	20	54	25	54	10	54	5	44	-5	44
	Godthaab	64	10	35	64	30	59	25	59	10	54	5	49	0	39
	Inglefield Bay	77	25	25	59	25	54	0	49	-15	44	-35	39	-40	29
	Julianehaab	60	43	25	74	30	64	30	69	10	54	0	54	-5	54
	Kap Tobin	70	25	25	54	25	54	20	49	0	34	-25	39	-20	29
	Narssarssuaq	61	11	35	79	30	74	20	74	5	59	-10	59	-35	59
Sondre Stromfjord		67	0	30	74	25	74	10	69	-10	69	-30	54	-40	48
	Thule	76	31	25	64	25	59	5	49	-20	34	-30	39	-35	34
	Tingmiarmint	62	32	30	69	30	59	15	59	15	49	10	39	0	39
	Upernavic	72	47	30	64	30	59	20	64	10	44	0	49	-15	44
Iceland	Reykjavic	64	8	40	69	30	64	30	64	15	59	10	54	10	54
	Seydisfjord	65	16	20	74	25	74	30	79	-5	64	0	59	0	59

Table C-23. Precipitation values for arctic and subarctic areas

LOCATION		NORTH LATITUDE Deg	Min	PRECIPITATION YEARLY: SNOW DEPTH (IN) Maximum Depth	Month	Average Depth	Period	MEAN PRECIPITATION (IN) Snow	Rain	Total
Alaska	Anchorage	61	10	27.8	Jan	6.39	Oct - Mar	—	—	14.3
	Aniak	61	35	32.3	Jan	6.85	Oct - Apr	—	—	19.0
	Barrow	71	18	22.5	Mar	10.70	Sep - May	—	—	5.3
	Barter Island	70	7	—	—	—	—	—	—	5.0
	Big Delta	64	0	54.3	Jan	11.20	Sep - May	—	—	15.0
	Cordova	60	30	29.0	Jan	8.05	Oct - Apr	132.0	131.8	145.0
	Fairbanks	64	49	54.3	Jan	9.67	Sep - May	—	—	11.9
	Galena	64	43	—	—	12.87	Oct - Apr	—	—	17.0
	Kotzebue	66	52	48.3	Mar	13.19	Sep - May	—	—	9.0
	Nome	64	30	74.0	Mar	15.70	Oct - May	—	—	17.4
	Umiat	69	22	22.5	Mar	10.70	Sep - May	—	—	5.0
	Wales	65	37	74.0	Mar	15.69	Oct - May	—	—	10.5
	Wiseman	67	26	—	—	—	—	—	—	7.5
Canada	Aklavic	68	14	48.0	Mar	14.10	Oct - Apr	40.0	5.0	9.0
	Alert	82	30	—	—	—	—	10.0	Neg	1.0
	Arctic Bay	73	0	13.0	Mar	8.55	Sep - Apr	40.0	3.0	7.0
	Baker Lake	64	18	17.5	Apr	10.34	Nov - Apr	50.0	6.0	11.0
	Cambridge Bay	69	7	17.0	Apr	9.31	Sep - May	36.0	4.0	7.6
	Chesterfield	63	20	32.0	Dec	13.54	Oct - May	53.0	6.0	11.3
	Clyde	70	27	25.0	Apr	14.82	Feb - Apr	65.0	4.0	10.5
	Coppermine	67	49	69.0	Apr	18.82	Oct - May	40.0	5.0	9.0
	Coral Harbor	64	12	40.0	Feb	17.81	Oct - May	59.0	5.0	10.9
	Dawson	64	4	45.0	Feb	15.13	Oct - Apr	45.0	7.5	12.0
	Eureka	80	0	—	—	15.37	Oct - May	10.0	Neg	1.0
	Fort Providence	61	20	33.0	Dec	12.83	Oct - Apr	45.0	8.0	12.5
	Fort Smith	61	1	33.0	Mar	10.90	Oct - Apr	42.0	8.5	12.7
	Frobisher Bay	63	45	74.0	Mar	21.10	Oct - Apr	80.0	7.5	15.5
	Holman Island	70	30	16.0	Mar	5.73	Oct - May	34.0	3.5	6.9
	Isachsen	78	47	—	—	—	—	10.0	Neg	1.0
	Mould Bay	76	14	—	—	—	—	15.0	1.0	2.5
	Norman Weils	65	17	51.4	Jan	17.34	Oct - Apr	40.0	7.0	11.0
	Nueltin Lake	60	30	—	—	—	—	55.0	9.0	14.5
	Padloping Island	67	6	65.0	Jan	49.00	Jan - Apr	—	—	15.0
	Resolute	74	43	25.6	May	12.44	Oct - May	30.0	1.0	4.0
	Snag	62	22	—	—	—	—	60.0	8.0	14.0
	Watson Lake	60	7	37.8	Feb	15.55	Oct - Apr	60.0	9.5	15.5
	Whitehorse	60	43	21.8	Feb	6.73	Oct - Apr	50.0	9.5	14.5
	Yellowknife	62	28	32.0	Jan	12.79	Oct - Apr	40.0	7.5	11.5
Greenland	Angmagssalik	65	37	—	—	—	—	—	—	15.0
	Daneborg	74	18	—	—	—	—	—	—	8.0
	Dammarkshavn	76	46	—	—	—	—	—	—	5.0
	Godhavn	69	15	74.4	Apr	13.87	Oct - May	—	—	7.5
	Godthaab	64	10	58.9	Apr	10.63	Sep - May	—	—	18.0
	Inglefield Bay	77	25	—	—	—	—	—	—	5.0
	Julianehaab	60	43	43.3	Mar	7.38	Sep - Apr	—	—	40.0
	Kap Tobin	70	25	—	—	—	—	—	—	8.0
	Narssarssuaq	61	11	10.6	Jan	6.15	Jan - Apr	—	—	40.0
	Sondre Stromfjord	67	0	74.4	Apr	13.87	Oct - May	—	—	14.0
	Thule	76	31	4.7	Mar	1.87	Oct - Apr	—	—	4.0
	Tingmiarmint	62	32	—	—	—	—	—	—	20.0
	Upernavic	72	47	20.9	Dec	7.46	Sep - May	—	—	10.0
Iceland	Reykjavic	64	8	64.0	Mar	14.00	Oct - May	—	—	34.0
	Seydisfjord	65	16	—	—	—	—	—	—	20.0

Table C-24. Windchill factors

Cooling power of wind expressed as "equivalent chill temperature"

WIND SPEED (Knots)	WIND SPEED (mph)	AIR TEMPERATURE (°F) 40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
Calm	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
3-6	5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60	-70
7-10	10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
11-15	15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
16-19	20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
(Winds above 40 mph have little additional effect)		LITTLE DANGER					INCREASING DANGER (Flesh may freeze within 1 minute)							GREAT DANGER (Flesh may freeze within 30 seconds)								

ZULU TIME

Figure C-2, page C-22, shows the letter designations for each time zone. These designations are used by the US Armed Forces in communications and operational planning for the identification of zone time (ZT) in the varying time zones. Greenwich mean time or universal time, which is the ZT at Greenwich, is designated "Z" or "Zulu time." Zones to the east of Greenwich are designated alphabetically according to longitude, starting with A and ending with M; the letter J is not used. Zones to the west of Greenwich are similarly designated, starting with N and ending with M or Y (±12).

"Zulu" or "Z" time is used in communications when ships or activities in different time zones are involved. By looking at Figure C-2, the time anywhere in the world can be determined.

As an example, note that the eastern part of the United States lies in time zone R (Romeo), 5 hours later than Zulu time. Egypt lies in time zone B (Bravo), 2 hours earlier than Zulu time. The worldwide time conversion chart, Figure C-3, page C-24, shows that at 1800 hours on any given day in New York, it is 0100 hours on the next day in Egypt.

It is sometimes necessary to indicate the date as well as the time in official communications. This is done by prefixing the time group and letter designator with two digits which indicate the date of the current month. Thus, "170925Z" would indicate a date/time of GMT 0925 on the 17th of the current month. This is "Zulu time." If a month other than the current one is to be used, the date/time group with the appropriate designator is used and the name of the desired month is added as a suffix. If a year other than the current year is used, it is indicated after the month. If the date/time of the message was for 1640 on 23 May 1993, the full group would read 231640 May 93.

MEASUREMENTS, CONVERSIONS, AND EQUIVALENTS

Units of measure, their conversions, and their equivalents are shown in the following tables and figures.

- Table C-25, page C-26, shows weights and measures.
- Table C-26, page C-27, and Table C-27, page C-28, shows the equivalent units of weight and length.
- Figure C-4, page C-29, shows the conversion scale for km, NM, and st mi.
- Table C-28, page C-29, shows the equivalent units of volume.
- Table C-29, page C-30, shows the conversion factors for metric and US units.
- Table C-30, page C-31, shows the petroleum product weights, measures, and conversions; Table C-31, page C-33, shows the conversion factors for petroleum products; and Figure C-5, page C-34, shows the conversion scale for petroleum products.
- Table C-32, page C-35 shows the equivalent units of speed.
- Table C-33, page C-36, shows temperature conversion from centigrade to fahrenheit and Figure C-6, page C-36 shows the temperature conversion scale.

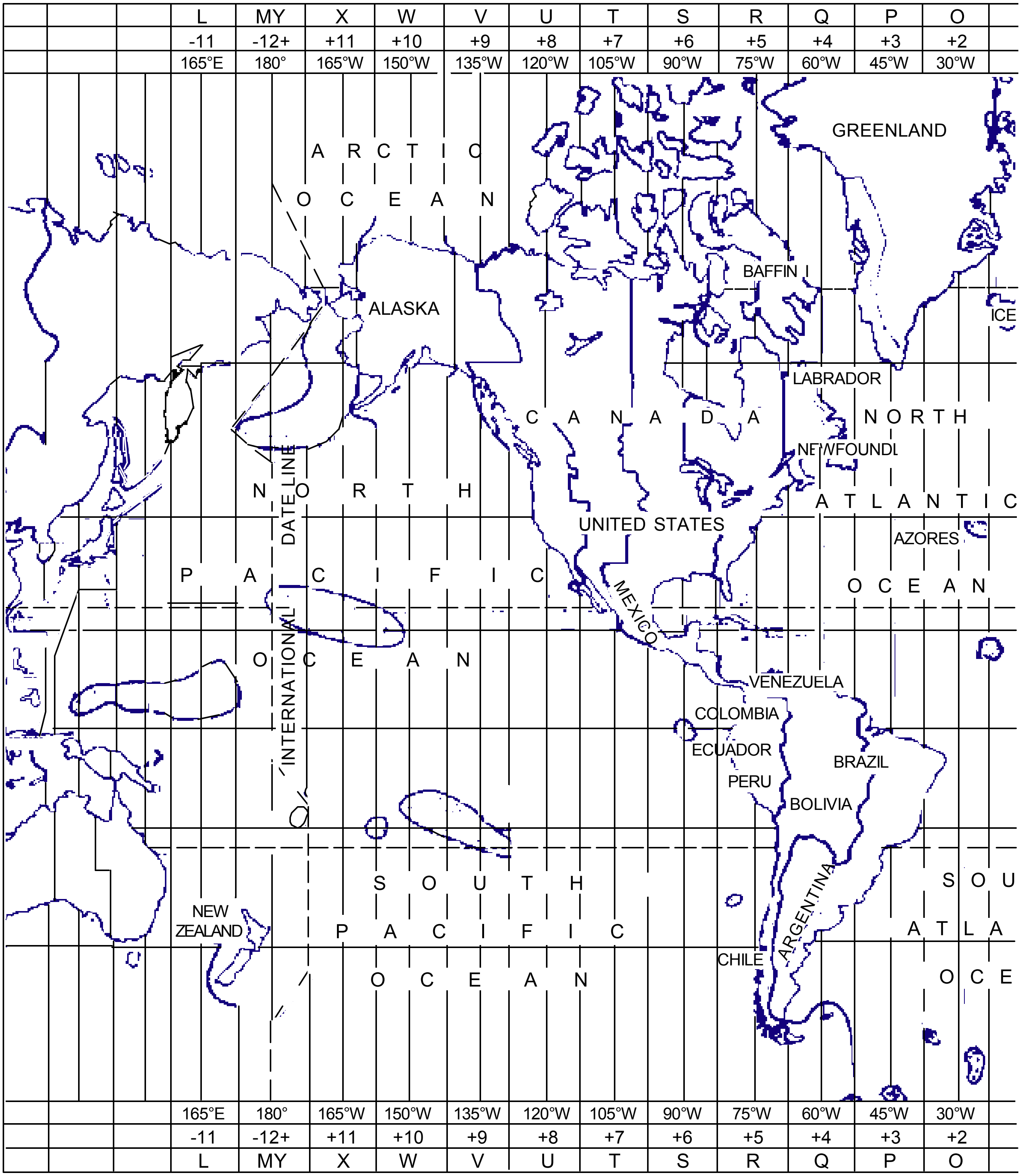


Figure C-2. Time zone chart

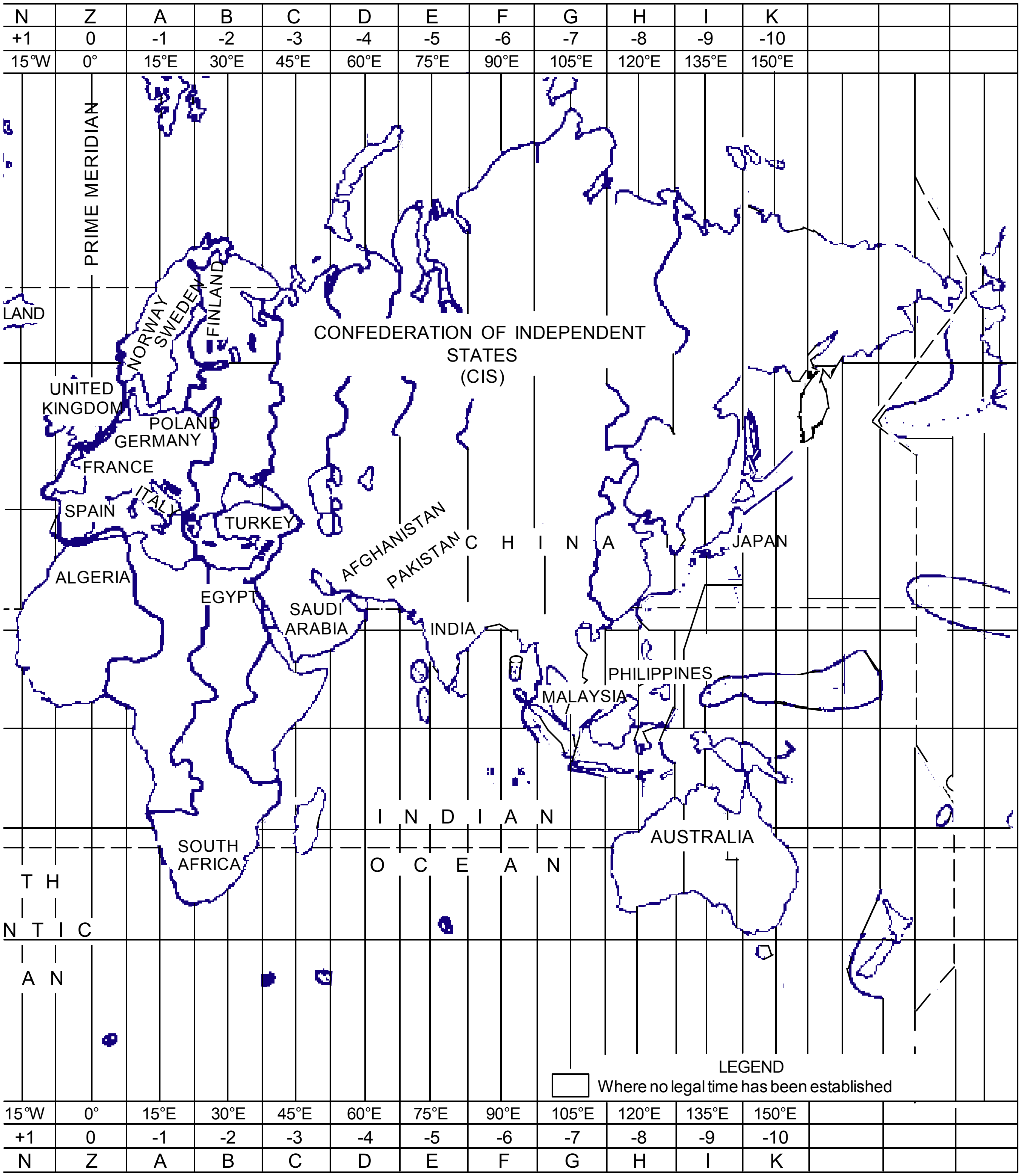


Figure C-2. Time zone chart (continued)

TIME ZONE		HOURS OF DAY IN																					
		PREVIOUS DAY																					
Z	0	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09
A	-1	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10
B	-2	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11
C	-3	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12
D	-4	I6	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13
E	-5	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
F	-6	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
G	-7	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
H	-8	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
I	-9	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
K	-10	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
L	-11	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
M	-12	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
N	+1	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08
O	+2	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07
P	+3	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06
Q	+4	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05
R	+5	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04
S	+6	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03
T	+7	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02
U	+8	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01
V	+9	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
W	+10	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
X	+11	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
Y	+12	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
		PREVIOUS DAY																					

Figure C-3. Worldwide time conversion chart

LOCAL MEAN TIME

SAME DAY | NEXT DAY

10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11
11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12
12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13
13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10
08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09
07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08
06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07
05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06
04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05
03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04
02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03
01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02
00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01
23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

SAME DAY

Figure C-3. Worldwide time conversion chart (continued)

Table C-25. Weights and measures

DRY MEASURE	FLUID MEASURE
1 pint = 33.6 cubic inches 2 pints = 1 quart 1 quart = 67.2 cubic inches 8 quarts = 1 peck 1 peck = 537.6 cubic inches 4 pecks = 1 bushel 1 bushel = 2,150.42 cubic inches	16 fluid ounces (USA) = 1 pint 20 fluid ounces (Britain) = 1 pint 1 pint = 4 gills 2 pints = 1 quart 4 quarts = 1 gallon 1 gallon = 8 1/2 pounds (approximate) 42 gallons, petroleum = 1 barrel
LINEAR MEASURE	**NAUTICAL MEASURE**
12 inches = 1 foot 3 feet = 1 yard 16 1/2 feet = 1 rod 5 1/2 yards = 1 rod 320 rods = 1 mile 1,760 yards = 1 mile 5,280 feet = 1 statute mile	6 feet = 1 fathom 100 fathoms = 1 cable length (ordinary) 120 fathoms = 1 cable length (US Navy) 6,080.2 feet = 1 nautical mile
CUBIC MEASURE	**SQUARE MEASURE**
1,728 cubic inches = 1 cubic foot 27 cubic feet = 1 cubic yard	144 square inches = 1 square foot 9 square feet = 1 square yard 4,840 square yards = 1 acre 43,560 square feet = 1 acre 640 acres = 1 square mile 272 1/4 square feet = 1 square rod

MEASUREMENT OF SURFACES AND SOLIDS		
Circumference of a circle	=	Diameter x 3.1416 or 6.2832 x radius
Area of a square or rectangle	=	Length x width
Area of a circle	=	Square of the diameter x .7854 or Square of the radius x 3.1416
Surface of a cube	=	Area of one side x 6
Surface of a sphere	=	Square of the diameter x 3.1416
Surface of a cylinder	=	Area of two ends + (height x circumference of one circular base)
Cubic content of a cube	=	Length x width x depth
Cubic content of a sphere	=	Cube of the diameter x .5236
Cubic content of a cylinder	=	Area of the circular base x the height of cylinder

Table C-26. Equivalent units of weight

METRIC UNITS	US UNITS
Millier (tonneau, metric ton)	2,204.6 pounds
Quintal	220.46 pounds
Kilogram	2.2046 pounds
Hectogram	3.5274 ounces
Decagram	0.3527 ounces
Gram	15.432 grains
Decigram	1.5432 grains
Centigram	0.1543 grains
Milligram	0.0154 grains

OUNCES TO GRAMS		GRAMS TO OUNCES		POUNDS TO KILOGRAMS		KILOGRAMS TO POUNDS	
1	28.3	1	0.04	1	0.45	1	2.20
2	56.7	2	0.07	2	0.91	2	4.41
3	85.0	3	0.11	3	1.36	3	6.61
4	113.4	4	0.14	4	1.81	4	8.82
5	141.7	5	0.18	5	2.27	5	11.02
6	170.1	6	0.21	6	2.72	6	13.23
7	198.4	7	0.25	7	3.18	7	15.43
8	226.8	8	0.28	8	3.63	8	17.64
9	255.1	9	0.32	9	4.08	9	19.84
10	283.5	10	0.35	10	4.54	10	22.05

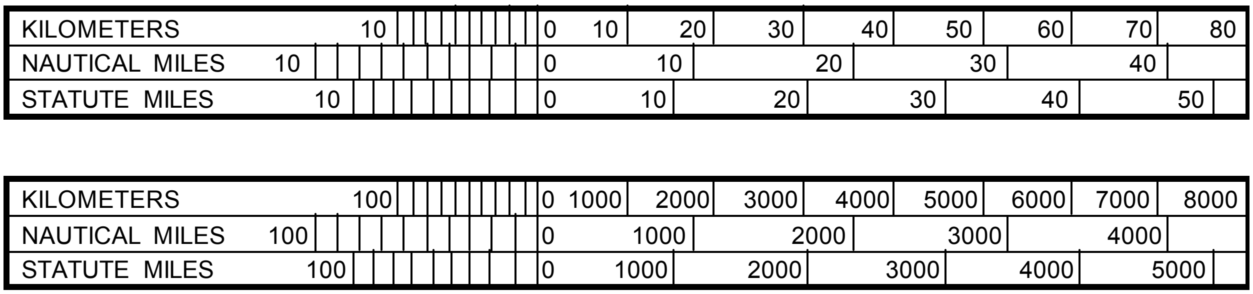
LONG UNIT	METRIC TONS	SHORT TONS	CUBIC TONS	KILOGRAMS	POUNDS	FEET
One long ton		1.0160	1.1200	1,016.0	2,240.0	
One metric ton	0.9842		1.1023	1,000.0	2,204.6	
One short ton	0.8929	0.9072		907.2	2,000.0	
One kilogram					2.2	
One measurement ton						40.0

Table C-27. Equivalent units of length

INCHES TO CENTIMETERS		CENTIMETERS TO INCHES	
1	2.54	1	0.39
2	5.08	2	0.79
3	7.62	3	1.18
4	10.16	4	1.57
5	12.70	5	1.97
6	15.24	6	2.36
7	17.78	7	2.76
8	20.32	8	3.15
9	22.86	9	3.54
10	25.40	10	3.94
11	27.94	11	4.33
12	30.48	12	4.72

FEET TO METERS		METERS TO FEET		YARDS TO METERS		METERS TO YARDS	
1	0.30	1	3.28	1	0.91	1	1.09
2	0.61	2	6.56	2	1.83	2	2.19
3	0.91	3	9.84	3	2.74	3	3.28
4	1.22	4	13.12	4	3.66	4	4.37
5	1.52	5	16.40	5	4.57	5	5.47
6	1.83	6	19.68	6	5.49	6	6.56
7	2.13	7	22.97	7	6.40	7	7.66
8	2.44	8	26.25	8	7.32	8	8.75
9	2.74	9	29.53	9	8.23	9	9.84
10	3.05	10	32.81	10	9.14	10	10.94

STATUTE MILES	TO KILO-METERS	KILO-METERS	TO STATUTE MILES	STATUTE MILES	TO NAUTICAL MILES	NAUTICAL MILES	TO STATUTE MILES
1	1.61	1	0.62	1	0.87	1	1.15
2	3.22	2	1.24	2	1.74	2	2.30
3	4.83	3	1.88	3	2.61	3	3.45
4	6.44	4	2.49	4	3.48	4	4.60
5	8.05	5	3.11	5	4.35	5	5.75
6	9.66	6	3.73	6	5.22	6	6.90
7	11.27	7	4.35	7	6.09	7	8.05
8	12.87	8	4.97	8	6.96	8	9.20
9	14.48	9	5.59	9	7.83	9	10.35
10	16.09	10	6.21	10	8.70	10	11.50



1 st mi = 0.87 NM   1 NM = 1.85 km
1 st mi = 1.61 km   1 NM = 1.15 st mi

Figure C-4. Conversion scale (km, NM, and st mi)

Table C-28. Equivalent units of volume

OUNCES TO MILLILITERS		MILLILITERS TO OUNCES	
1	29.57	10	0.34
2	59.15	20	0.68
3	88.72	30	1.01
4	118.29	40	1.35
5	147.87	50	1.69
6	177.44	60	2.03
7	207.01	70	2.37
8	236.59	80	2.71
9	266.16	90	3.04
10	295.74	100	3.38

QUARTS TO LITERS		LITERS TO QUARTS		GALLONS TO LITERS		LITERS TO GALLONS	
1	0.95	1	1.06	1	3.79	1	0.26
2	1.89	2	2.11	2	7.57	2	0.53
3	2.84	3	3.17	3	11.36	3	0.79
4	3.79	4	4.23	4	15.14	4	1.06
5	4.73	5	5.28	5	18.93	5	1.32
6	5.68	6	6.34	6	22.71	6	1.59
7	6.62	7	7.40	7	26.50	7	1.85
8	7.57	8	8.45	8	30.28	8	2.11
9	8.52	9	9.51	9	34.07	9	2.38
10	9.46	10	10.57	10	37.85	10	2.64

Table C-29. Conversion factors (metric and US units)

US OR IMPERIAL UNITS X	CONVERSION FACTOR =	METRIC UNITS	METRIC UNITS X	CONVERSION FACTOR =	US OR IMPERIAL UNITS
Acres	0.4947	Hectares	Centimeters	0.3937	Inches
Cubic feet	0.0283	Cubic meters	Cubic	0.0610	Cubic inches
Cubic inches	16.3872	Cubic centimeters	Cubic meters	35.3144	Cubic feet centimeters
Cubic inches	0.0164	Liters	Cubic meters	1.3079	Cubic yards
Cubic yards	0.7646	Cubic meters	Decameters	3.9317	Inches
Feet	0.3048	Meters	Grams	15.4324	Grains
Feet per second	18.288	Meters per minute	Grams	0.03527	Ounces (avdp)
Gallons (US)	3.7854	Liters	Hectares	2.4710	Acres
Gallons (imp)	4.543	Liters	Kilograms	2.2046	Pounds (avdp)
Grains	0.0648	Grams	Kilograms	35.2739	Ounces (avdp)
Inches	2.54	Centimeters	Kilometers	0.62137	Miles
Inches	0.0254	Meters	Liters	61.025	Cubic inches
Inches	25.4001	Millimeters	Liters	0.2642	Gallons (US)
Miles	1.6093	Kilometers	Liters	0.220	Gallons
Miles per hour	0.0447	Meters per minute	Liters	2.1134	Pints (US)
Ounces (avdp)	28.349	Grams	Liters	1.76	Pints (imp)
Ounces (avdp)	0.92835	Kilograms	Meters	3.2808	Feet
Pints (US)	0.4732	Liters	Meters	39.37	Inches
Pints (imp)	0.568	Liters	Meters	1.0936	Yards
Pounds (avdp)	0.45359	Kilograms	Meters per minute	0.0547	Feet per second
Square feet	0.0929	Square meters	Meters per second	2.237	Miles per hour
Square inches	6.4516	Square centimeters	Metric ton	2,204.6	Pounds
Square miles	2.590	Square kilometers	Millimeters	0.03937	Inches
Square yards	0.8361	Square meters	Square centimeters	0.155	Square inches
Yards	0.914	Meters	Square kilometers	0.3861	Square miles
			Square meters	1.1960	Square yards
			Square meters	10.764	Square feet

Table C-30. Petroleum product weights, measures, and conversions

PRODUCT/ PACKAGING	WEIGHT (lb)	VOLUME (Cubic Capacity) Actual (cu ft)	Planning Factor (cu ft)	CONVERSION FACTORS Gal to lb	Lb to gal	GALLONS PER STONs	LTONs	MTONs[1]	BARRELS PER LTONs[1]	PACKAGING PER STONs	LTONs	MTONs	VEHICLE CAPACITY FOR CARRYING FILLED CONTAINERS 1 1/2-ton tlr	2 1/2-ton trk	5-ton trk
AVGAS															
Bulk	—	—	—	5.90	0.169	339.0	379.7	—	9.04	—	—	—	—	—	—
55-gal drums[2]	373.0	9.03	11	6.91	0.145	289.4	324.2	187.8	—	5.36	6.00	3.48	8	14	28
55-gal drums[3]	389.0	8.80	11	7.20	0.139	277.8	311.1	192.8	—	5.14	5.76	3.57	8	13	26
55-gal drums[4]	364.0	9.20	11	6.90	0.145	289.9	324.6	181.2	—	5.49	6.15	3.42	9	14	28
5-gal cans[5]	40.5	0.81	1	8.00	0.125	250.0	280.0	200.0	—	49.40	55.30	40.00	74	124	248
Jet fuel (JP4)															
Bulk	—	—	—	6.42	0.156	312.0	349.4	—	8.06	—	—	—	—	—	—
55-gal drums[2]	399.0	9.03	11	7.39	0.135	270.0	302.4	187.8	—	5.01	5.61	3.48	8	13	25
55-gal drums[3]	415.0	8.80	11	7.68	0.130	260.0	291.2	192.7	—	4.82	5.40	3.57	8	12	24
55-gal drums[4]	392.0	9.20	11	7.40	0.135	270.0	302.4	181.2	—	5.10	5.71	3.42	8	14	28
MOGAS															
Bulk	—	—	—	6.11	0.164	327.3	366.6	—	8.73	—	—	—	—	—	—
55-gal drums[2]	384.0	9.03	11	7.11	0.141	281.2	315.1	187.8	—	5.21	5.83	3.48	8	13	26
55-gal drums[3]	400.0	8.80	11	7.41	0.135	269.9	302.3	192.8	—	5.00	5.60	3.57	8	13	26
55-gal drums[4]	376.0	9.20	11	7.09	0.141	282.1	315.9	181.2	—	5.32	5.96	3.42	8	14	28
5-gal cans[5]	41.6	0.81	1	8.32	0.120	240.4	269.2	200.0	—	48.10	53.80	40.00	73	121	242
Diesel fuel															
Bulk	—	—	—	6.99	0.143	286.1	320.5	—	7.63	—	—	—	—	—	—
55-gal drums[2]	432.0	9.03	11	8.00	0.125	250.0	280.0	187.8	—	4.63	5.19	3.48	7	12	24
55-gal drums[3]	448.0	8.80	11	8.30	0.120	241.0	269.9	192.7	—	4.46	5.00	3.57	7	12	24
55-gal drums[4]	430.0	9.20	11	8.11	0.123	246.6	276.2	181.2	—	4.65	5.21	3.42	7	12	24
5-gal cans[5]	46.0	0.81	1	9.20	0.109	317.4	243.5	200.0	—	43.50	48.70	40.00	66	109	218
Kerosene															
Bulk	—	—	—	6.80	0.147	294.1	329.4	—	7.84	—	—	—	—	—	—
55-gal drums[2]	421.0	9.03	11	7.80	0.128	256.4	287.1	187.8	—	4.75	5.32	3.48	8	12	24
55-gal drums[3]	437.0	8.80	11	8.09	0.124	247.2	276.9	192.8	—	4.58	5.13	3.57	7	12	24
55-gal drums[4]	351.0	9.20	11	6.62	0.151	302.1	338.3	181.2	—	5.70	6.38	3.42	9	15	30
5-gal cans[5]	45.0	0.81	1	9.00	0.111	222.2	248.9	200.0	—	44.40	49.80	40.00	67	112	224
Lub oils															
Bulk	—	—	—	7.60	0.132	263.2	294.7	—	7.02	—	—	—	—	—	—
55-gal drums[2]	472.0	9.03	11	8.58	0.117	233.1	261.0	191.3	—	4.24	4.75	3.48	7	11	22
55-gal drums[3]	488.0	8.80	11	8.87	0.113	225.5	252.5	196.4	—	4.10	4.59	3.57	7	11	22
55-gal drums[4]	462.0	9.20	11	8.56	0.117	233.6	261.7	184.6	—	4.33	4.85	3.42	7	11	22

Table C-30. Petroleum product weights, measures, and conversions (continued)

PRODUCT/ PACKAGING	WEIGHT (lb)	VOLUME (Cubic Capacity) Actual (cu ft)	Planning Factor (cu ft)	CONVERSION FACTORS Gal to lb	Lb to gal	GALLONS PER STONs	LTONs	MTONs[1]	BARRELS PER LTONs[1]	PACKAGING PER STONs	LTONs	MTONs	VEHICLE CAPACITY FOR CARRYING FILLED CONTAINERS 1 1/2-ton tlr	2 1/2-ton trk	5-ton trk
Lub oils (continued)															
5-gal cans[5]	49.0	0.81	1	9.80	0.102	204.1	228.6	181.2	—	40.80	45.70	40.00	62	103	206
l-qt cans (12 per case)	35.0	0.88	1	—	—	—	—	—	—	58.00	64.90	40.00	86	143	286
1-qt cans (24 per case)	60.0	1.60	2	—	—	—	—	—	—	33.40	37.30	20.00	50	84	168
5-qt cans (6 per case)	77.0	1.90	2	—	—	—	—	—	—	26.00	29.10	20.00	39	65	130
Greases															
25-lb pails	29.0	0.95	1	—	—	—	—	—	—	69.00	77.20	40.00	104	173	346
5-lb cans (6 per case)	44.0	1.10	2	—	—	—	—	—	—	45.40	50.90	20.00	69	114	227
Fog oils															
SGF1															
Bulk	—	—	—	7.11	0.140	281.0	314.0	—	7.49	—	—	—	—	—	—
55-gal drums[2]	438.0	9.03	11	8.11	0.123	246.6	276.2	191.3	—	4.50	5.02	3.48	7	11	22
55-gal drums[3]	588.0	8.80	11	8.40	0.110	238.0	266.6	196.4	—	4.32	4.84	3.57	7	11	22
55-gal drums[4]	421.0	9.20	11	8.10	0.123	246.9	276.5	184.6	—	4.57	5.12	3.42	7	11	22
SGF2															
Bulk	—	—	—	6.99	0.143	286.0	320.0	—	7.63	—	—	—	—	—	—
55-gal drums[2]	431.0	9.03	11	7.99	0.120	250.3	280.3	191.3	—	4.54	5.09	3.48	7	11	22
55-gal drums[3]	616.0	8.80	11	8.28	0.120	241.5	270.5	196.4	—	4.39	4.90	3.57	7	11	22
55-gal drums[4]	478.0	9.20	11	7.90	0.121	253.1	283.5	184.6	—	4.68	5.25	3.42	7	11	231

[1] For ocean-shipping, storage, and pipeline computations, bulk petroleum products are usually measured in barrels of 42 gallons each or in LTONs.

[2] 18-gauge standard weighs 54 pounds empty; filled to 54 gallons with light products, 55 gallons with heavy products.

[3] 16-gauge standard weighs 70 pounds empty; filled to 54 gallons with light products, 55 gallons with heavy products.

[4] 18-gauge limited standard weighs 53 pounds empty; fill to 53 gallons with light products, 54 gallons with heavy products.

[5] For planning purposes, weight of MOGAS may be taken as 42 pounds and weight of lube oil for engines as 50 pounds per 5-gallon can, including weight of can. Five-gallon cans weigh approximately 11 pounds empty.

NOTE: Factors in this table are based on US gallons. 1 imperial gallon = 1.2010 US gallons; 1 liter = 0.2462 US gallons.

Table C-31. Conversion factors – petroleum products

MULTIPLY	BY	TO OBTAIN
Cubic feet	7.48	Gallons
Cubic feet	0.1782	Barrels
Cubic feet	0.025	Tons, measurement
Cubic feet	0.01	Tons, register
Cubic feet	28.32	Liters
Cubic inches	0.0043	Gallons
Cubic meters	264.2	Gallons
Cubic meters	6.29	Barrels
Gallons	231.0	Cubic inches
Gallons	0.1337	Cubic feet
Gallons	3.7854	Liters
Gallons	0.0238	Barrels
Gallons (gasoline)	6.103	Pounds
Gallons (gasoline)	0.0031	Tons, short
Gallons (gasoline)	0.0033	Tons, measurement
Gallons (gasoline)	0.0027	Tons, long
Gallons (gasoline)	0.0026	Tons, metric
Gallons (oil)	7.434	Pounds
Kiloliters	0.159	Barrels
Liters	0.2642	Gallons
Liters	0.001	Cubic meters
Pounds	0.1639	Gallons (gasoline)
Pounds	0.1345	Gallons (oil)
Tons, long	367.21	Gallons (gasoline)
Tons, measurement	303.03	Gallons (gasoline)
Tons, measurement	1.0	Tons, short (grease)
Tons, measurement	1.1086	Tons, short (gasoline)
Tons, measurement	1.4285	Tons, short (gasoline in drums)
Tons, measurement	1.2048	Tons, short (oil in drums)
Tons, measurement	40.0	Cubic feet (gasoline)
Tons, metric	373.10	Gallons (gasoline)
Tons, short	327.8	Gallons (gasoline)
Tons, short (gasoline)	0.9195	Tons, measurement
Tons, short (gasoline in drums)	0.7	Tons, measurement
Tons, short (grease)	1.0	Tons, measurement
Tons, short (oil in drums)	0.83	Tons, measurement

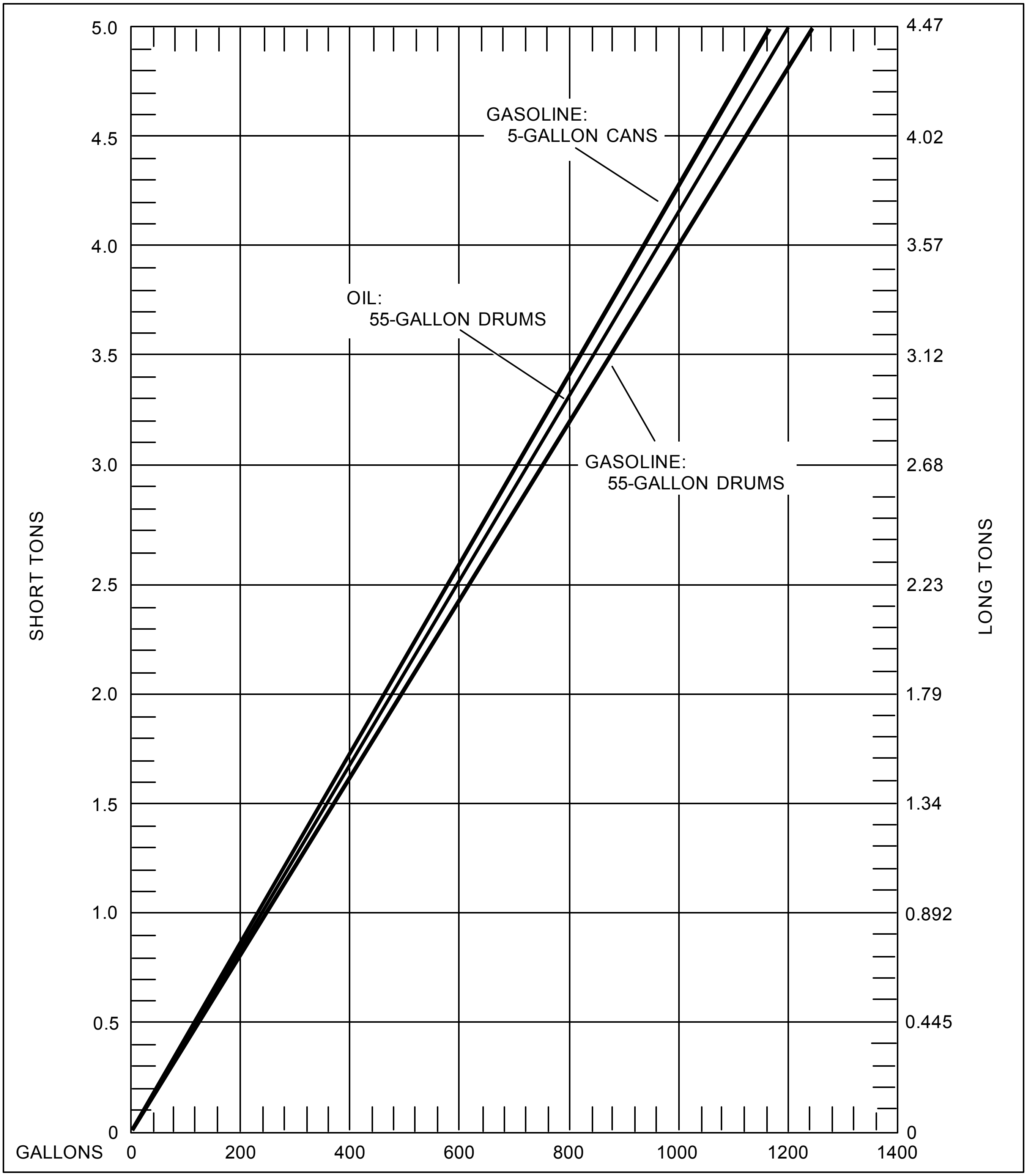


Figure C-5. Conversion scale (gallons, STONs, and LTONs) – petroleum products

Table C-32. Equivalent units of speed

MPH	KNOTS	FT/SEC	KMPH	M/SEC	MPH	KNOTS	FT/SEC	KMPH	M/SEC
1	0.8684	1.4667	1.6093	0.447	26	22.50	38.20	41.90	11.60
2	1.74	2.94	3.23	0.897	27	23.40	39.70	43.50	12.10
3	2.59	4.41	4.83	1.34	28	24.30	41.20	45.10	12.50
4	3.46	5.90	6.45	1.78	29	25.20	42.60	46.70	13.00
5	4.34	7.33	8.05	2.23	30	26.00	44.20	48.30	13.40
6	5.20	8.80	9.65	2.68	31	26.90	45.60	50.00	13.90
7	6.07	10.30	11.30	3.13	32	27.80	47.00	51.50	14.30
8	6.95	11.80	12.90	3.58	33	28.60	48.50	53.00	14.73
9	7.81	13.22	14.50	4.03	34	29.50	50.00	54.55	15.20
10	8.68	14.67	16.09	4.47	35	30.40	51.50	56.50	15.65
11	9.55	16.20	17.70	4.92	36	31.20	53.00	58.00	16.10
12	10.40	17.62	19.30	5.37	37	32.00	54.50	59.70	16.50
13	11.23	19.10	20.90	5.82	38	32.90	56.00	61.40	17.00
14	12.10	20.60	22.60	6.27	39	33.80	57.50	62.80	17.40
15	13.00	22.10	24.20	6.71	40	34.60	58.80	64.50	17.83
16	13.90	23.50	25.80	7.16	41	35.60	60.50	66.00	18.38
17	14.75	25.00	27.40	7.63	42	36.40	61.90	67.70	18.80
18	15.60	26.40	28.90	8.05	43	37.30	63.40	69.20	19.20
19	16.45	28.00	30.60	8.50	44	38.20	64.80	71.00	19.70
20	17.40	29.30	32.20	8.95	45	38.90	66.50	72.50	20.20
21	18.20	30.90	33.80	9.39	46	40.00	67.50	74.00	20.60
22	19.10	32.20	35.40	9.85	47	40.70	69.10	75.90	21.00
23	20.00	33.80	37.10	10.30	48	41.50	70.50	77.50	21.40
24	20.80	35.30	38.60	10.75	49	42.40	72.00	79.00	21.80
25	21.70	36.70	40.30	11.15	50	43.50	73.80	80.50	22.30

Table C-33. Temperature conversions – centigrade to Fahrenheit

°C	to °F	°F	to °C
-20	-4	0	-17.8
-10	14	10	-12.2
0	32	20	-6.7
10	50	30	-1.1
20	68	40	4.4
30	86	50	10.0
40	104	60	15.6
50	122	70	21.1
60	140	80	26.7
70	158	90	32.2
80	176	100	37.8
90	194	120	48.9
100	212	140	60.0
		160	71.1
		180	82.2
		200	93.3

°C = 5/9 (°F - 32)

°F = 9/5 (°C + 32)

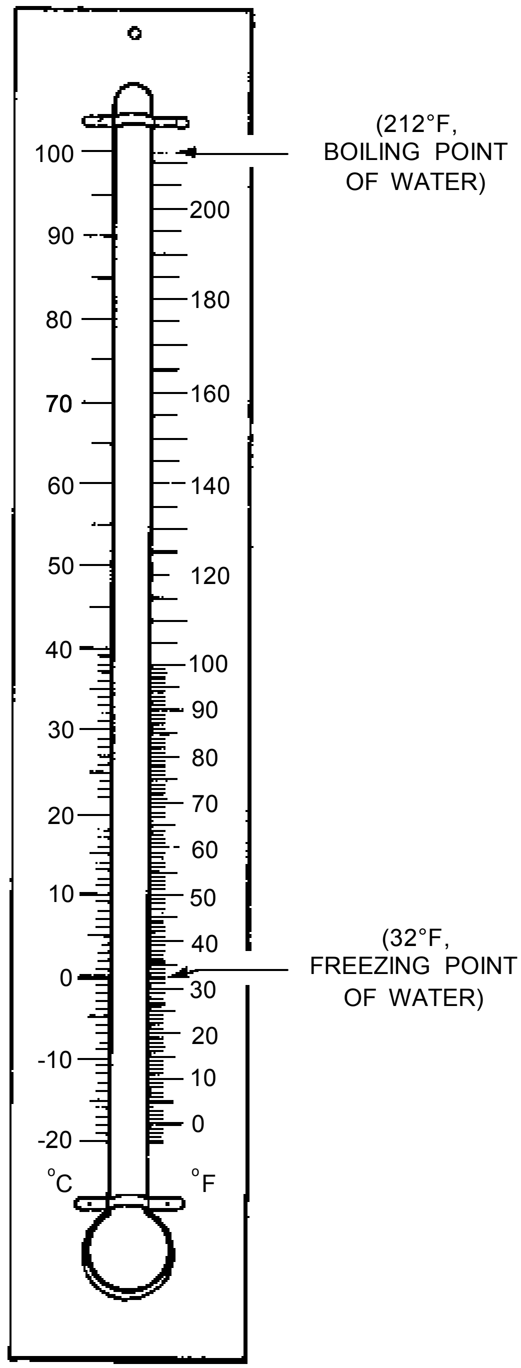


Figure C-6. Temperature conversion scale

APPENDIX D
INTERNATIONAL MARKINGS AND ROAD SIGNS

Army personnel who are stationed or who travel in overseas areas should be familiar with the standardized vehicle markings and road signs prescribed by NATO and the Geneva Convention. This appendix discusses these markings and signs in detail and provides corresponding illustrations.

NATO MILITARY VEHICLE MARKINGS

NATO armed forces have agreed to use standard markings for vehicles. These markings are not necessarily used at all times but, when used, should conform to the guidelines below. The rear of a trailer is marked in the same manner as its prime mover; there is no need to mark the front of a trailer. If necessary for security reasons, vehicle markings may be covered or removed when directed by the field commander or his superior authority. Standard NATO markings include:

- Registration numbers – numbers or a combination of letters and numbers, as required by the nation concerned.
- National symbols – shown, at a minimum, front and rear to identify each country's vehicles. Service symbols may be superimposed on national symbols or appear separately.
- Speed limits – placed on vehicles as directed by the nation concerned.
- Tactical markings – stripes and geometrical figures, sometimes with a name, for identification within units. Markings should be large enough to make ground-to-ground identification of vehicles possible; colors may be used. The design and position of these markings are prescribed by the field commander for easy battlefield recognition. They are removed when vehicles are permanently released from the jurisdiction of the commander prescribing their use.
- Ground-to-air recognition markings – red and yellow fluorescent panels, approximately 6 feet by 2 feet 3 inches (1.80 meters by 0.68 meters), equipped with tie cords. Panels are draped on vehicles in a standard, unchanging pattern that differs from displays prescribed for other recognition purposes (front lines, targets, and so forth). Theater commanders prescribe the arrangement of panels and conditions under which they will be used.
- Special-purpose vehicle identification:
  - Military police and other traffic control vehicles – prescribed markings placed front and rear.
  - Ambulances and other vehicles used exclusively for medical purposes – marked according to Geneva convention rules with a red cross or crescent on a square or round white background painted on side body panels, body roof, cab roof, and rear doors or panel.
  - Bomb disposal unit vehicles – will be marked IAW existing national regulations and international agreements (i.e., in Western Europe these vehicles must have all mud guards painted red).

- Red flag – indicates danger.
- Priority-vehicle markings – equilateral triangles with red borders and symbols on white backgrounds placed on the front and rear of a vehicle. The commander may mark any vehicle that has priority over all other vehicles. Examples of priority vehicles are those carrying special liaison officers, priority dispatches, and damage-assessment personnel. A single priority sign may be used if visible from both front and rear. The sign should be as large as the vehicle's dimensions permit. The symbol inside the triangle identifies the authorizing commander. Priority signs must be removable to avoid misuse. They are used only on direct orders of the commander concerned. See Figure D-1 for an example of a vehicle priority sign.

GENEVA CONVENTION ROAD SIGNS

The Geneva Convention road signs discussed here were agreed to at the United States Conference on Road and Motor Transport in 1949. Although not military, these signs should be familiar to Army personnel who will encounter them overseas.

Dimensions of the signs are standardized in each country for uniformity. In general, there are two sizes for each type of sign – standard and reduced. The reduced size is used where conditions preclude, or safety does not require, the standard size. In exceptional cases, a small sign may be used in built-up areas or to repeat the main sign.

Danger Signs (Class I)

Danger signs are red bordered equilateral triangles with black or dark-colored symbols on white or yellow backgrounds. The triangles point upward except the "priority road ahead" sign, which points downward. The length of each standard side is not less than 0.9 meters (35.4 inches); of each reduced side, not less than 0.6 meters (23.6 inches). Overall height of signs is not more than 2.2 meters (86.6 inches) above ground. Away from built-up areas, signs are placed not less than 0.6 meters (23.6 inches) above ground. Signs are placed to be clearly visible without impeding pedestrians. See Figure D-2, page D-3, for examples of Class I signs.

Instructional Signs (Class II)

There are two types of instructional signs – prohibitory (Class II A) and mandatory (Class II B). Class II A signs are red-bordered circles with black or dark-colored symbols on a white or yellow background. Class II B signs are blue circles with white symbols. Standard size is at least 0.6 meters (23.6 inches) in diameter; reduced size, 0.4 meters (15.7 inches). Bottom of sign must be at least 0.6 meters (23.6 inches) above ground; top of sign must not be more than 2.2 meters (86.6 inches) above ground. Signs are placed close to the point where the requirement starts and at intervals along the route. See Figure D-3, page D-4 for examples of Class II signs.

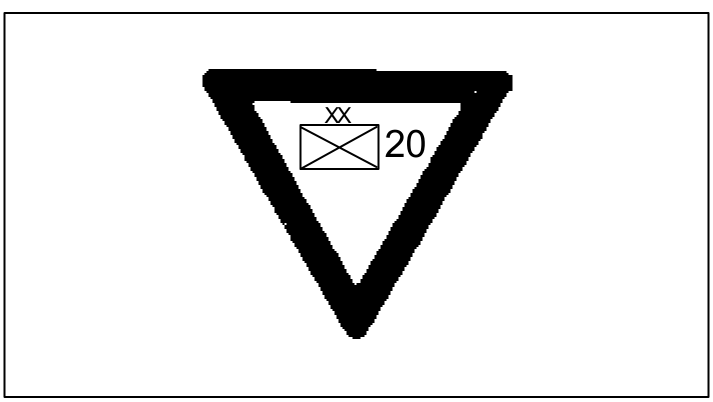


Figure D-1. NATO vehicle priority sign

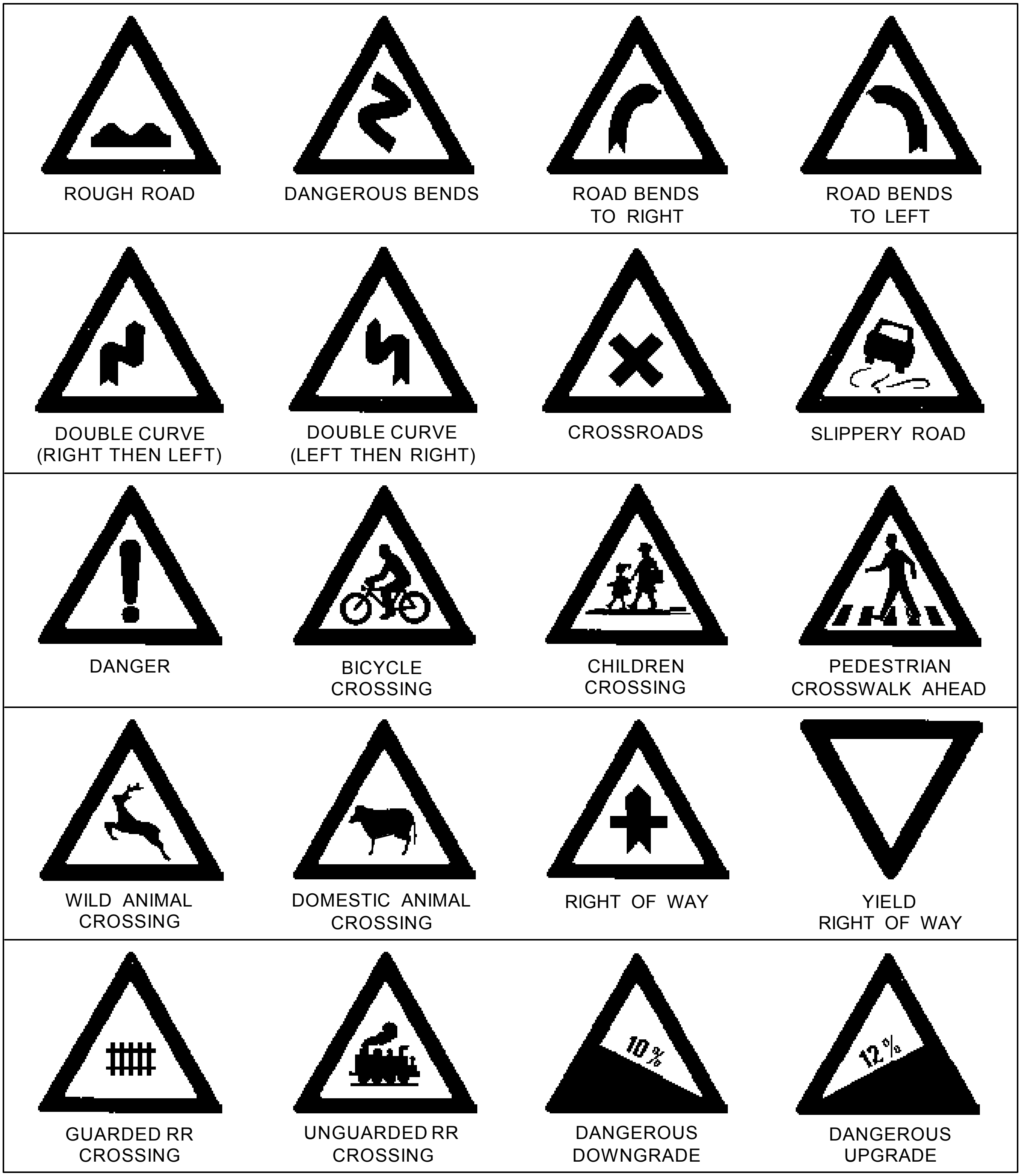


Figure D-2. Class I (danger) signs – Geneva Convention

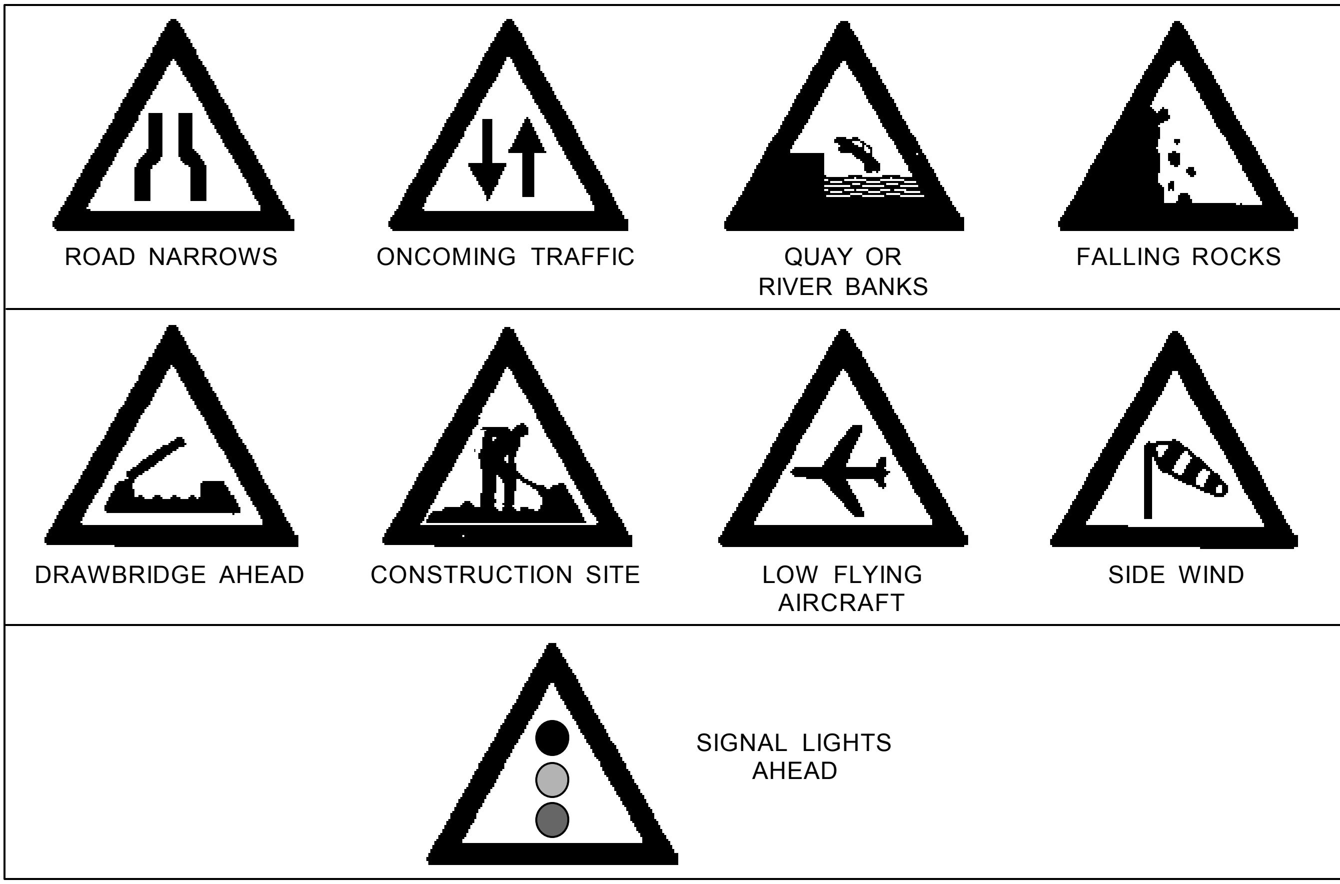


Figure D-2. Class I (danger) signs – Geneva Convention (continued)

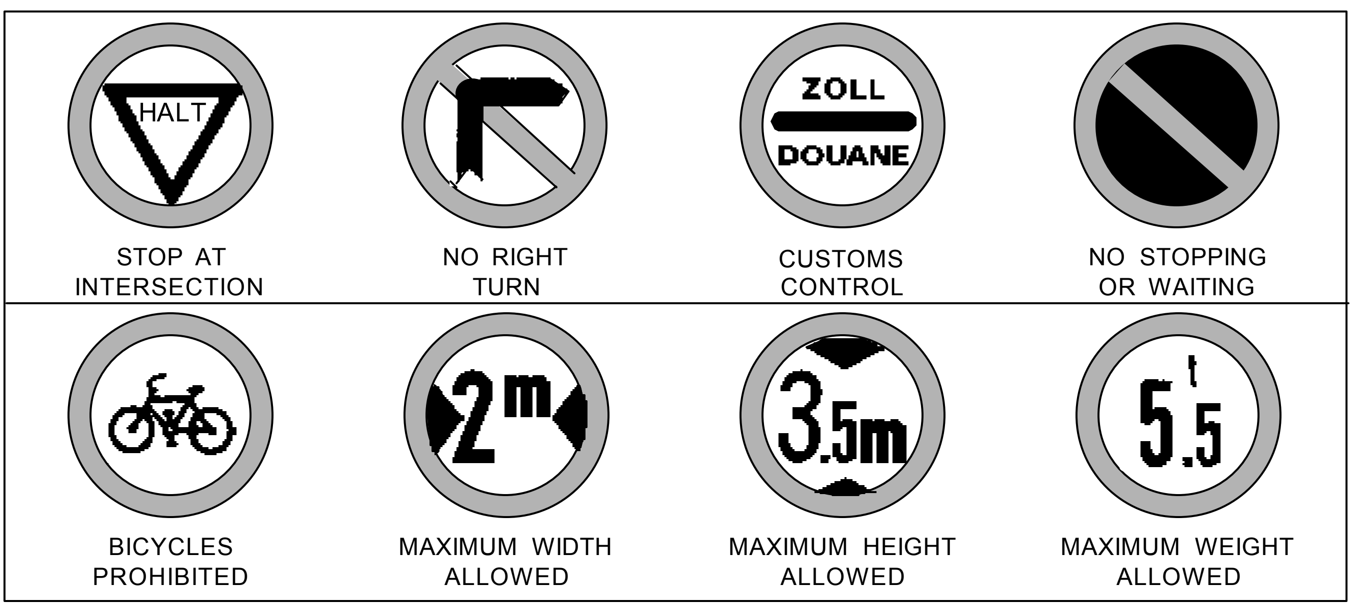


Figure D-3. Class II (instructional) signs—Geneva Convention

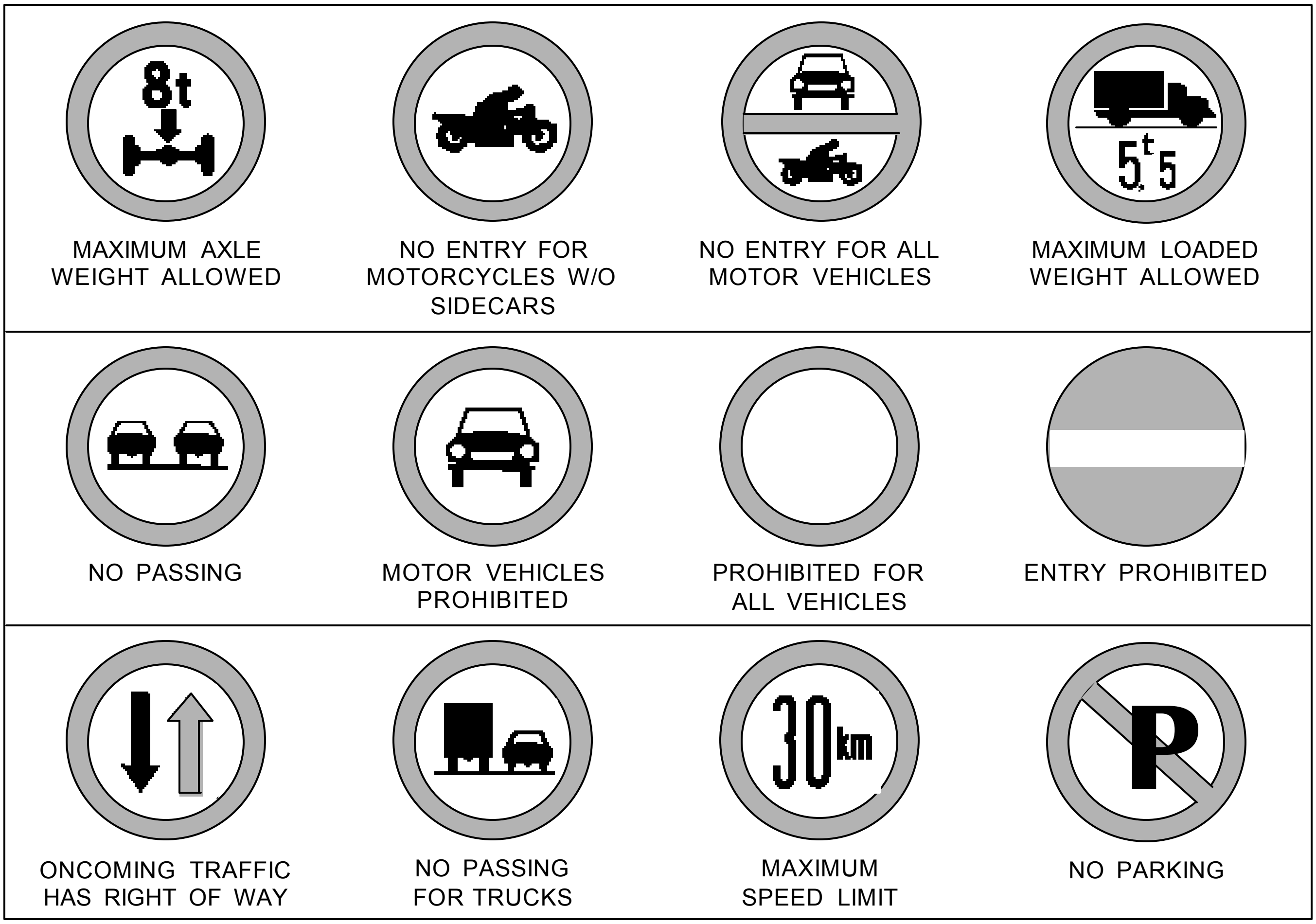


Figure D-3. Class II (instructional) signs—Geneva Convention (continued)

Informational Signs (Class III)

There are three types of informational signs – indication (Class III A), direction and advance direction (Class III B), and place identification (Class III C). Signs are usually rectangular. Colors may or may not be specified. If they are not specified, red may be used but is not the dominant color. See Figure D-4, page D-6, for examples of Class III signs.

Class III A. These signs are blue rectangles with variously colored symbols, except for priority-road signs. Priority-road signs are diamond-shaped, either white with black rims or yellow with dark rims. Standard size is at least 0.6 meters (23.6 inches) square; reduced size, 0.4 meters (15.7 inches). If signs are repeated within built-up areas, square size is 0.25 meters (9.8 inches). Class III A signs indicate parking, hospitals, first aid stations, telephones, service stations, and priority roads.

Class III B. These rectangular signs have either light backgrounds with dark symbols or dark backgrounds with light symbols. They are large enough to be easily understood by drivers in time for them to comply. Advance direction signs are placed from 100 to 250 meters (328 to 820 feet) from the intersection on normal roads. On special roads, such as concrete multilane roads, the distance is increased to 500 meters (1,640 feet). Direction signs are rectangular; the longer side is horizontal and ends in an arrowhead. Names of places lying in the direction of the arrow may be added to the sign. Figures indicating distances, if given, are inscribed between the name of the place and the arrowhead.

Class III C. These rectangular signs have light backgrounds with dark symbols or dark backgrounds with light symbols. The 40 signs are placed with the long side horizontal. Their size and location are adequate for nighttime visibility. Class III C signs are placed before the beginning of built-up areas and at other points necessary to indicate place locations.

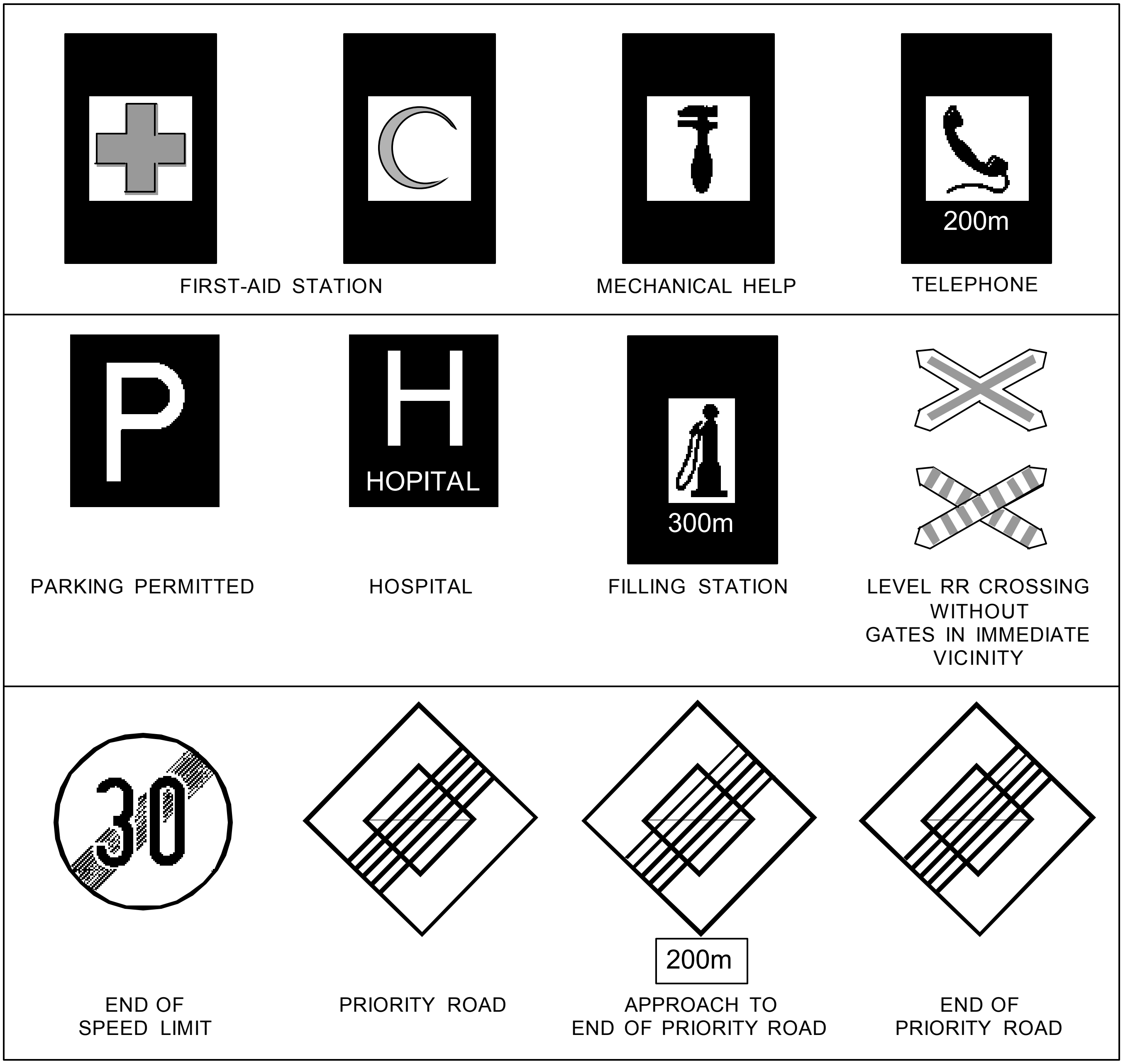


Figure D-4. Class III (informational signs)—Geneva Convention

NATO ROAD SIGNS

To aid the movement of NATO forces in any territory controlled by operational military command or national authority, governments belonging to NATO have adopted a standard system of military route signs. This system includes the signs prescribed by the Geneva Convention as well as others. There are three types of NATO road signs: regulatory, hazard, and guide signs.

Regulatory Signs

These square-shaped signs are black with white symbols except for bridge classification, stop signs, and signs of various shapes, used by the military to control civilians under specified conditions. Regulatory signs are used to regulate and control traffic and to define the light line. See STANAG 2174, Annex B for descriptions of regulatory signs.

Hazard Signs

These triangular-shaped signs are white with black symbols. Hazard signs indicate traffic hazards (i.e., dangerous corners, steep hills, or crossroads) and are used only in areas under military authority. A purely military sign not included in the international (Geneva convention) system or host country's system has a white background with the legend or symbol in black. In the communication and rear combat zones, military hazard signs should only be used IAW existing agreements with national authorities, and only under very exceptional circumstances.

Guide Signs

These signs indicate locations, distances, directions, routes, and similar information. These signs are described as follows:

- Route guide signs are rectangular with white symbols on black backgrounds. Signs are placed with the long side vertical. Odd numbers indicate axial routes; even numbers, lateral routes.
- Casualty evacuation route guide signs are either rectangular or cross-shaped with red symbols on white backgrounds.
- Detour signs are diamond-shaped with a black arrow (barred or not) on a white background.
- Directional disks are circular, less than 0.30 meters (16 inches) in diameter, with a black arrow (barred or not) on a white background. Eight equally spaced holes around its circumference allow the disk to be nailed with the arrow pointing in any direction. Directional disks supplement other guide signs or major unit signs to indicate route direction. Battalions and lower units are not permitted to install directional disks.

See Figure D-5 for examples of standard NATO road signs.

NATO WARNING SIGNS

Roads and areas within NATO nations containing contamination, minefields, booby traps, or unexploded bombs are marked with triangular signs IAW STANAG 2002. See Figure D-6, page D-8, for examples.

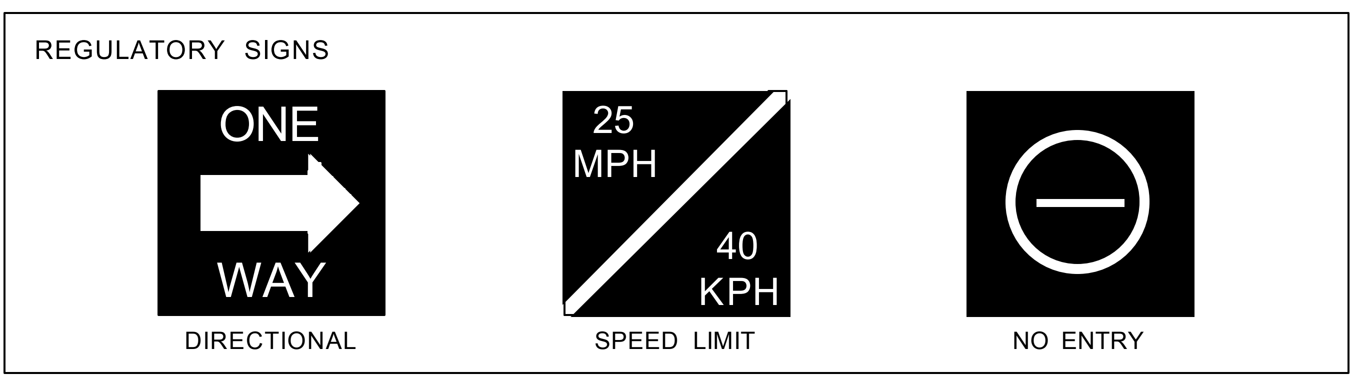


Figure D-5. Standard NATO road signs

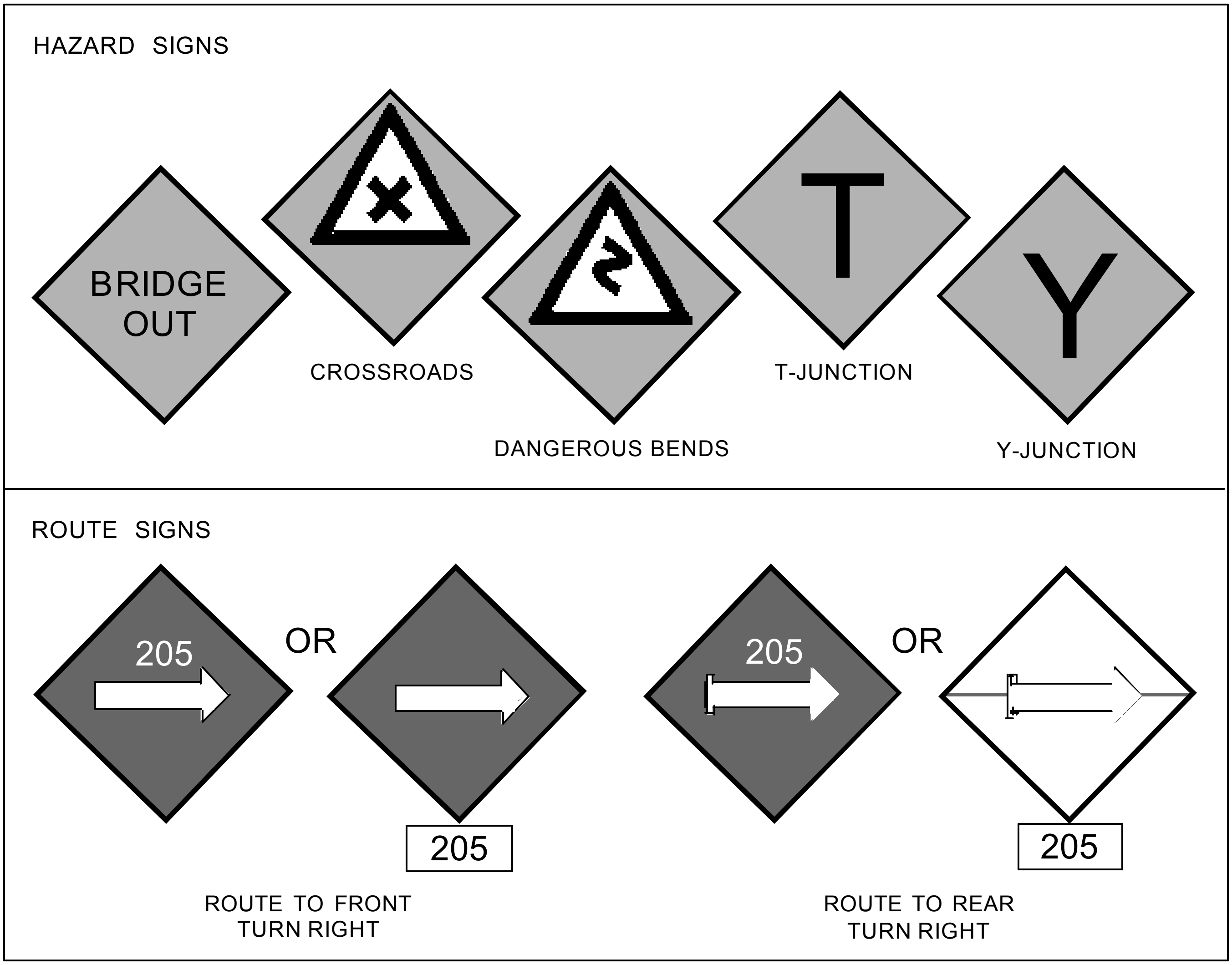


Figure D-5. Standard NATO road signs (continued)

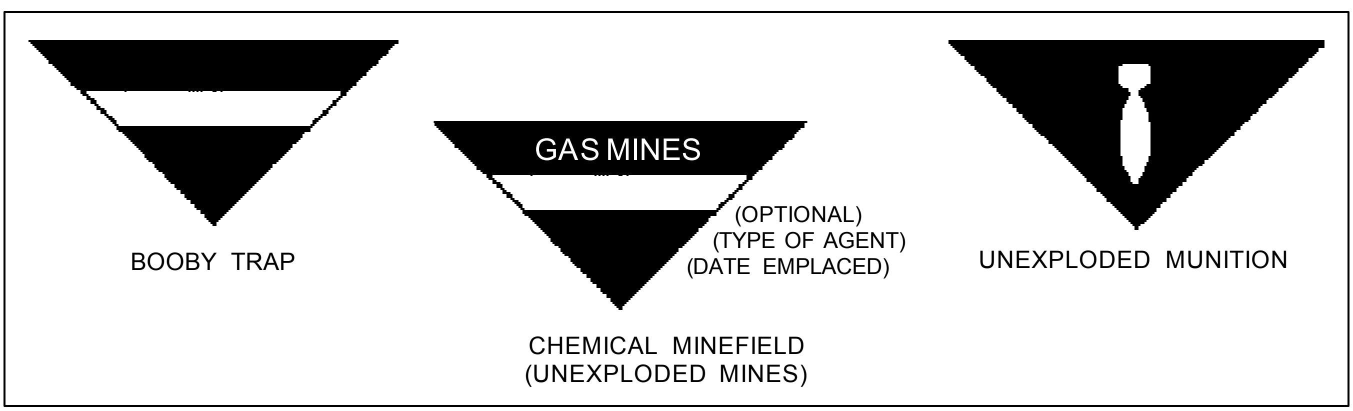


Figure D-6. NATO contaminated dangerous land area signs

APPENDIX E
DOT CHART 10
HAZARDOUS MATERIALS MARKING, LABELING & PLACARDING GUIDE

This appendix contains facsimiles of hazardous materials warning labels, placards, and package markings and guidelines for their use as set forth in DOT Chart 10. Full-color copies of DOT Chart 10 can be obtained by calling 1-800-467-4922, extension 3, or writing OHMIT/DHM-51, Washington, DC 20590. Regulations and requirements governing the transport of hazardous materials by all modes of transportation can be found in 49 CFR, Parts 100-199. For detailed information and to determine compliance, refer to that and other applicable publications.

GENERAL GUIDELINES ON THE USE OF WARNING LABELS AND PLACARDS

LABELS

See Figure E-1, page E-2, for hazardous materials warning labels. The following guidelines apply to the use of warning labels:

- On and after 1 October 1993, those labels in boxes marked "TRANSITION-2001" will not be authorized for use under 49 CFR, Part 172, Subpart E. (NOTE: These labels may be used IF they were affixed to a package offered for transportation and transported prior to 1 October 2001, and the package was filled with hazardous materials prior to 1 October 1991.)
- For classes 1, 2, 3, 4, 5, 6 and 8, text indicating a hazard (e.g., "CORROSIVE") IS NOT required on a label. The label must otherwise conform to Subpart E (Section 172.405).
- Any person who offers a hazardous material for transportation MUST label the package, if required [Section 172.400(a)].
- The Hazardous Materials Table (Section 172.101) identifies the proper label(s) for the hazardous material listed.
- When required, labels must be printed on or affixed to the surface of the package near the proper shipping name [Section 172.406(a)].
- When two or more labels are required, they must be displayed next to each other [Section 172.406(c)].
- Labels may be affixed to packages when not required by regulations, provided each label represents a hazard of the material contained in the package (Section 172.401).

See 49 CFR, Part 172, Subpart E for complete labeling regulations.

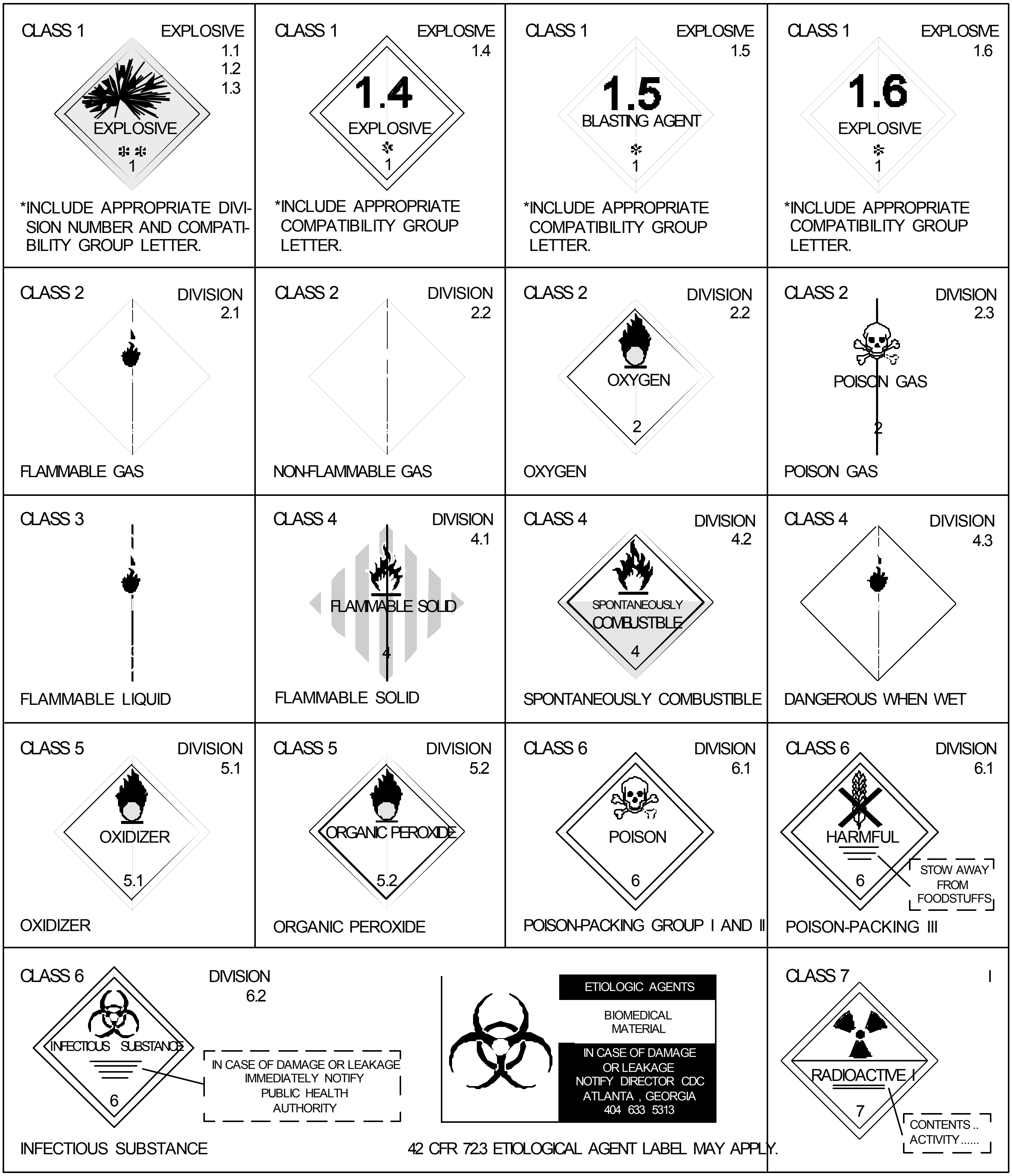


Figure E-1. Hazardous materials warning labels

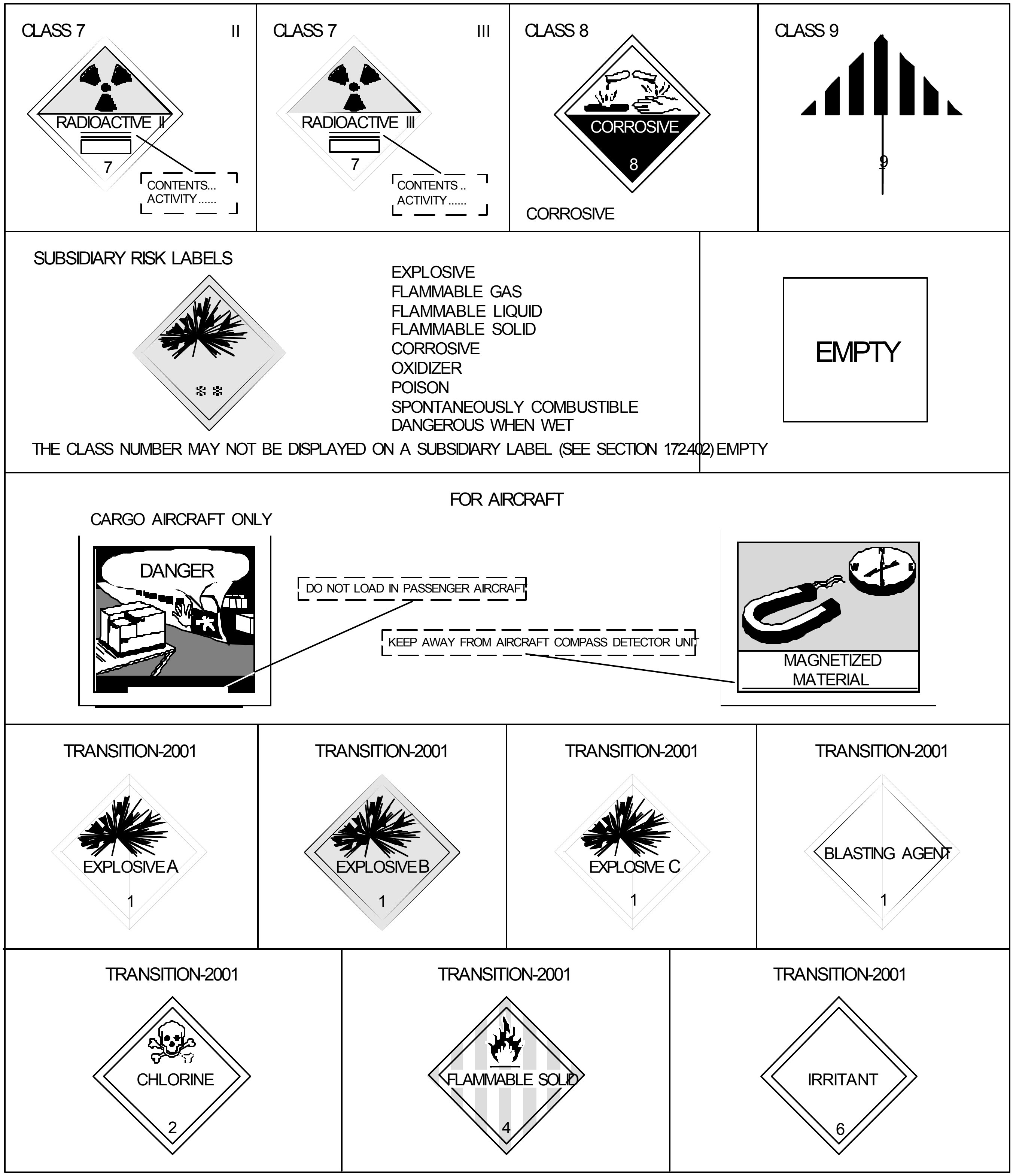


Figure E -1. Hazardous materials warning labels (continued)

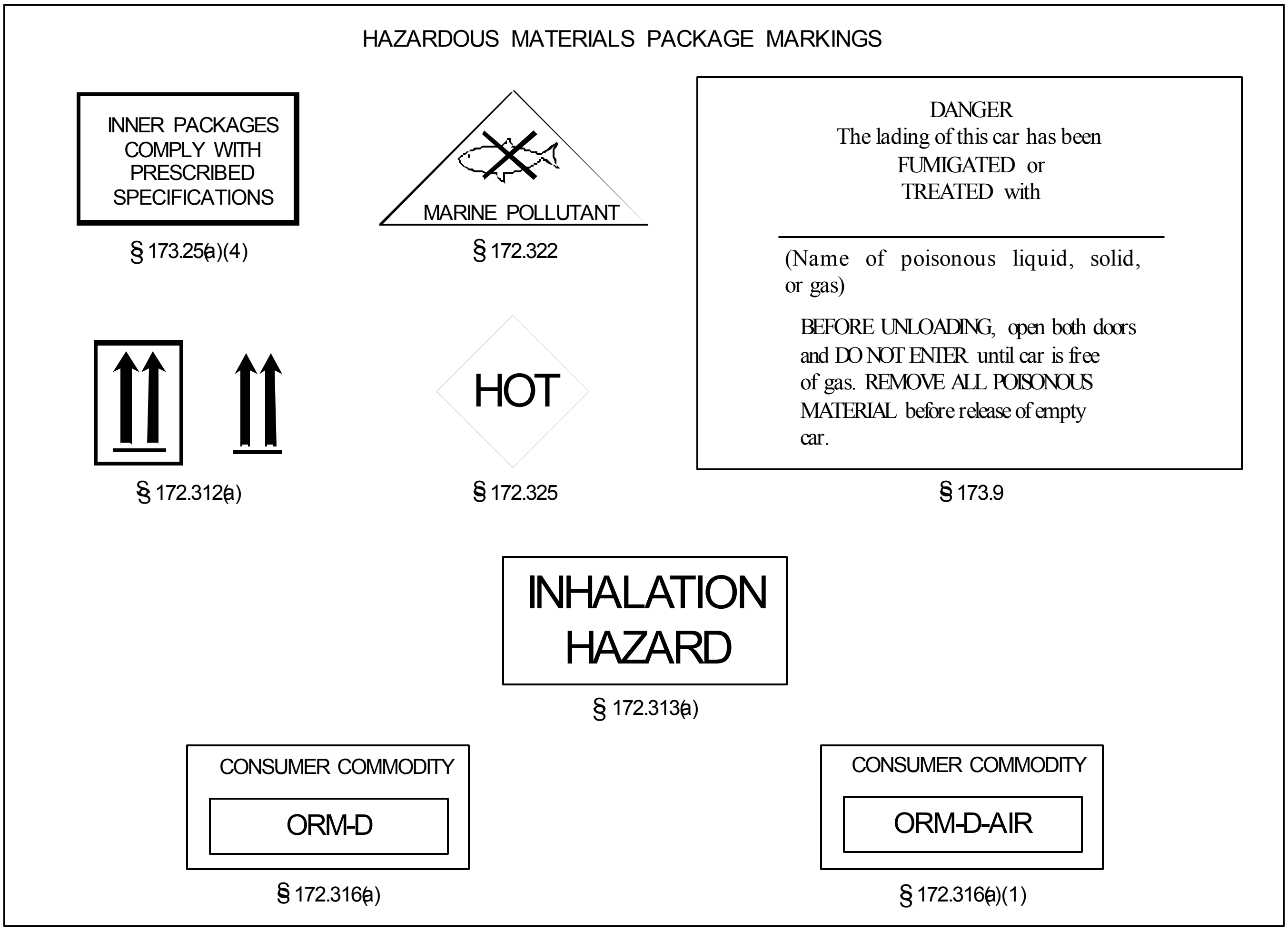


Figure E-1. Hazardous materials warning labels (continued)

PLACARDS

See Figure E-2, page E-5, for hazardous materials warning placards and Tables E-1 and E-2, page E-8, for a list of hazard classes and placard names. The following guidelines apply to the use of placards:

- All of the placards shown in this appendix may be used to satisfy the placarding requirements contained in 49 CFR, Part 172, Subpart F.
- Each person who offers for transportation or transports any hazardous material subject to the Hazardous Materials Regulations shall comply with all applicable requirements of Subpart F.
- Placards may be displayed for a hazardous material even when not required, if the placarding otherwise conforms to the requirements of Subpart F.
- For other than Class 7 or the OXYGEN placard, text indicating a hazard (e.g., “CORROSIVE”) is not required on a placard [Section 172.519(b)].
- Any transport vehicle, freight container, or rail car containing any quantity of material listed in Table E-1 (Section 172.504) must be placarded.
- When the gross weight of all hazardous materials covered in Table E-2 is less than 454 kg (1,001 lbs), no placard is required on a transport vehicle or freight container [Section 172.504].

Refer to 49 CFR, Part 172, Subpart F for complete placarding regulations.

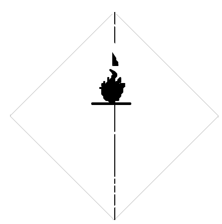
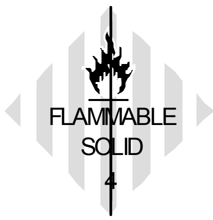
CLASS 1  EXPLOSIVES *ENTER DIVISION NUMBER 1.1, 1.2, OR 1.3 AND COMPATIBIL-ITY GROUP LETTER, WHEN REQUIRED. PLACARD ANY QUANTITY.	CLASS 1  EXPLOSIVES 1.4 *ENTER COMPATIBILITY GROUP LETTER, WHEN REQUIRED. PLACARD 454 KG (1,001 LBS) OR MORE.	CLASS 1  EXPLOSIVES 1.5 *ENTER COMPATIBILITY GROUP LETTER, WHEN REQUIRED. PLACARD 454 KG (1,001 LBS) OR MORE.	CLASS 1  EXPLOSIVES 1.6 *ENTER COMPATIBILITY GROUP LETTER, WHEN REQUIRED. PLACARD 454 KG (1,001 LBS) OR MORE.
CLASS 2  OXYGEN PLACARD 454 KG (1,001 LBS) OR MORE, GROSS WEIGHT OF EITHER COMPRESSED GAS OR REFRIGERATED LIQUID.	CLASS 2  FLAMMABLE GAS PLACARD 454 KG (1,001 LBS) OR MORE.	CLASS 2  NON-FLAMMABLE GAS PLACARD 454 KG (1,001 LBS) OR MORE GROSS WEIGHT.	CLASS 2  POISON GAS PLACARD ANY QUANTITY OF DIVISION 2.3 MATERIAL.
CLASS 3  FLAMMABLE PLACARD 454 KG (1,001 LBS) OR MORE.	CLASS 3  GASOLINE MAY BE USED IN THE PLACE OF FLAMMABLE ON A PLACARD DISPLAYED ON A CARGO TANK OR A PORTABLE TANK BEING USED TO TRANSPORT GASOLINE BY HIGHWAY.	CLASS 3  COMBUSTIBLE PLACARD A COMBUSTIBLE LIQUID WHEN TRANSPORTED IN BULK. SEE § 172.504(f)(2) FOR USE OF FLAMMABLE PLACARD IN PLACE OF COMBUSTIBLE PLACARD.	CLASS 3  FUEL OIL MAY BE USED IN PLACE OF COMBUSTIBLE ON A PLACARD DISPLAYED ON A CARGO TANK OR PORTABLE TANK BEING USED TO TRANSPORT BY HIGHWAY FUEL OIL NOT CLASSED AS A FLAMMABLE LIQUID.

Figure E-2. Hazardous materials warning placards

CLASS 4

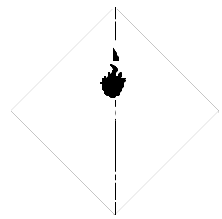


FLAMMABLE SOLID
PLACARD 454 KG (1,001 LBS) OR MORE.

CLASS 4

SPONTANEOUSLY COMBUSTIBLE
PLACARD 454 KG (1,001 LBS) OR MORE.

CLASS 4



DANGEROUS WHEN WET
PLACARD ANY QUANITY OF DIVISION 4.3 MATERIAL.

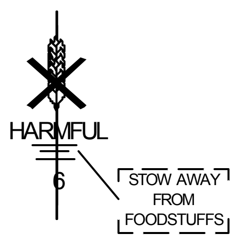
CLASS 5

OXIDIZER
PLACARD 454 KG (1,001 LBS) OR MORE.

CLASS 5

ORGANIC PEROXIDE
PLACARD 454 KG (1,001 LBS) OR MORE.

CLASS 6



KEEP AWAY FROM FOOD
PLACARD 454 KG (1,001 LBS) OR MORE.

CLASS 6

POISON
PLACARD ANY QUANTITY OF 6.1, PGI, INHALATION HAZARD ONLY. PLACARD 454 KG (1,001 LBS) OR MORE OF PGI OR II, OTHER THAN PGI INHALATION HAZARD.

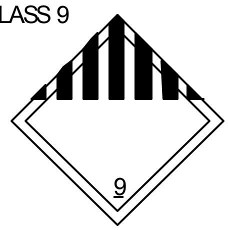
CLASS 7

RADIOACTIVE
PLACARD ANY QUANTITY OF PACKAGES BEARING THE RADIOACTIVE III LABEL. CERTAIN LOW SPECIFIC ACTIVITY RADIOACTIVE MATERIALS IN "EXCLUSIVE USE" WILL NOT BEAR THE LABEL, BUT RADIOACTIVE PLACARD IS REQUIRED.

CLASS 8

CORROSIVE
PLACARD 454 KG (1,001 LBS) OR MORE.

CLASS 9



MISCELLANEOUS
NOT REQUIRED FOR DOMESTIC TRANSPORTATION. PLACARD 454 KG (1,001 LBS) OR MORE GROSS WEIGHT OF A MATERIAL WHICH PRESENTS A HAZARD DURING TRANSPORT, BUT IS NOT INCLUDED IN ANY OTHER HAZARD CLASS.

DANGEROUS
PLACARD 454 KG (1,001 LBS) GROSS WEIGHT OF TWO OR MORE CATEGORIES OF HAZARDOUS MATERIALS LISTED IN TABLE 2. A FREIGHT CONTAINER, UNIT LOAD DEVICE, MOTOR VEHICLE, OR RAIL CAR WHICH CONTAIN NON-BULK PACKAGINGS WITH TWO OR MORE CATEGORIES OF HAZARDOUS MATERIALS THAT REQUIRE PLACARDS SPECIFIED IN TABLE 2 MAY BE PLACARDED WITH A DANGEROUS PLACARD INSTEAD OF THE SEPARATE PLACARDING SPECIFIED FOR EACH OF THE MATERIALS IN TABLE 2. HOWEVER, WHEN 2,268 KG (5,000 LBS) OR MORE OF ONE CATEGORY OF MATERIAL IS LOADED AT ONE FACILITY, THE PLACARD SPECIFIED IN TABLE 2 MUST BE APPLIED.

Figure E-2. Hazardous materials warning placards (continued)

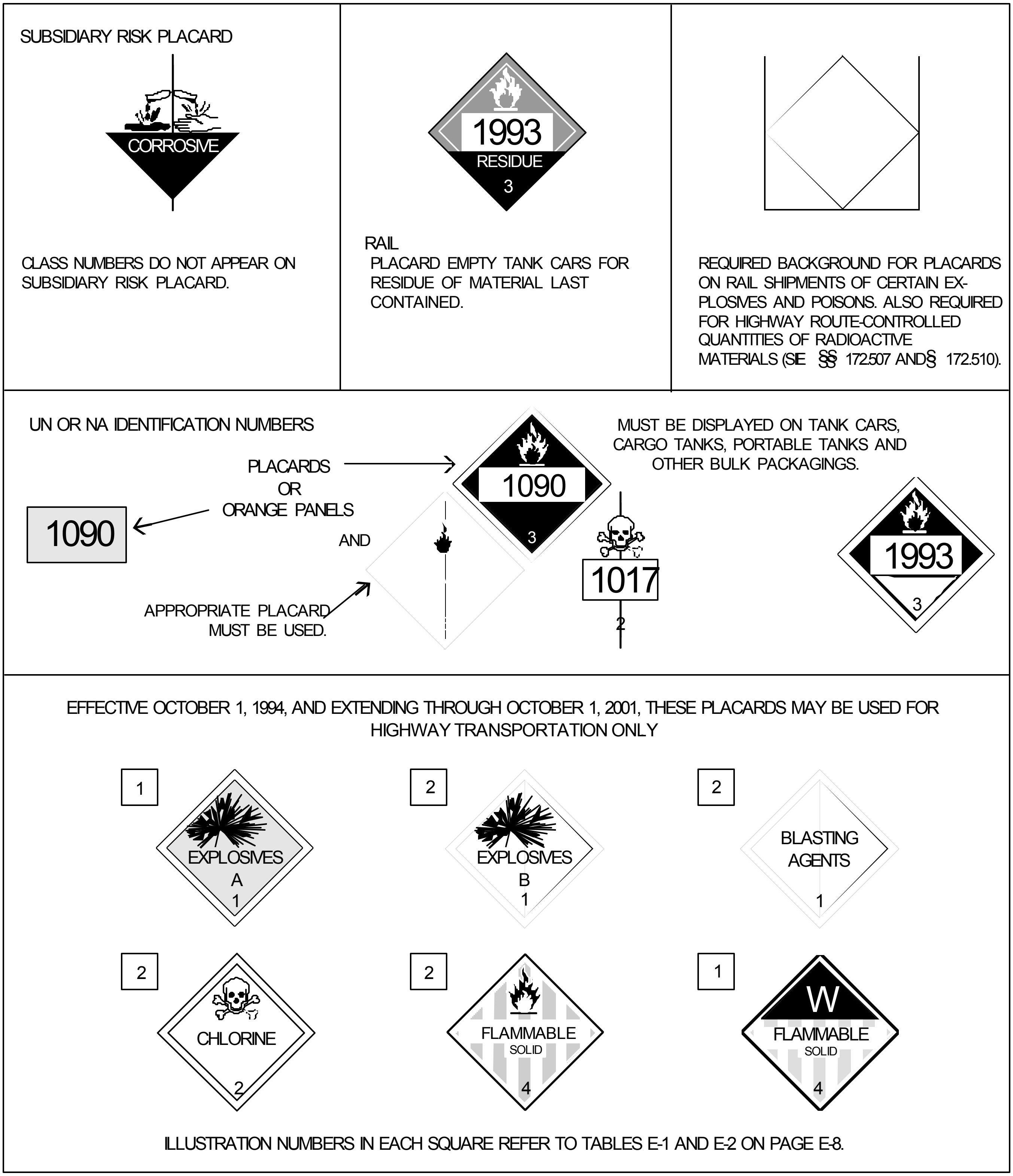


Figure E-2. Hazardous materials warning placards (continued)

Table E-1. Placard (any quantity)

HAZARD CLASS OR DIVISION	PLACARD NAME
1.1	EXPLOSIVES 1.1
1.2	EXPLOSIVES 1.2
1.3	EXPLOSIVES 1.3
2.3	POISON GAS
4.3	DANGEROUS WHEN WET
6.1 (PGI, PIH only)	POISON
7 (Radioactive Yellow III)	RADIOACTIVE

Table E-2. Placard (1,001 pounds or more)

HAZARD CLASS OR DIVISION	PLACARD NAME
1.4	EXPLOSIVES 1.4
1.5	EXPLOSIVES 1.5
1.6	EXPLOSIVES 1.6
2.1	FLAMMABLE GAS
2.2	NON-FLAMMABLE GAS
3	FLAMMABLE
Combustible Liquid	COMBUSTIBLE
4.1	FLAMMABLE SOLID
4.2	SPONTANEOUSLY COMBUSTIBLE
5.1	OXIDIZER
5.2	ORGANIC PEROXIDE
6.1 (PGI or II, other than PGI PIH)	POISON
6.1 (PGIII)	KEEP AWAY FROM FOOD
6.2	NONE
8	CORROSIVE
9	CLASS 9
ORM-D	NONE

POISONOUS MATERIALS

Materials which meet the inhalation toxicity criteria have additional "communication standards" prescribed by the HMR. First, the words "Poison-Inhalation Hazard" must be entered on the shipping paper, as required by 49 CFR, Section 172.203(m)(3). Second, packagings must be marked "Inhalation Hazard" in accordance with Section 172.313(a). Lastly, transport vehicles, freight containers, portable tanks and unit load devices that contain a poisonous material subject to the "Poison-Inhalation Hazard" shipping description, must be placarded with a POISON or POISON GAS placard, as appropriate. This shall be in addition to any other placard required for that material in Section 172.504. See Figure E-3 for illustrations.

§172.554

§172.313

Figure E-3. Poisonous materials markings and placards

GLOSSARY

AA&E arms, ammunition, and explosives

AAFES Army and Air Force Exchange Service

AAR Association of American Railroads

abn airborne

ABS American Bureau of Shipping

AC Active Component

ACD automated cargo documentation

acft aircraft

ACL allowable cargo (cabin) load

ACofS Assistant Chief of Staff

ACR armored cavalry regiment

ADA air defense artillery

A/DACG arrival/departure airfield control group

ADC area damage control

admin administration

ADP automatic data processing

ADPE automatic data processing equipment

ADPS automatic data processing system

AFB Air Force base

AFOE assault follow-on echelon

AG Adjutant General

AGL above ground load

Air Mobility Command (AMC) the single-manager operating agency for designated airlift service; operates as a TCC of the USTRANSCOM; provides worldwide airlift and aerial refueling support for the DOD (formerly Military Airlift Command)

AIS automated information system

ALOC air lines of communication

allowable cargo (cabin) load the amount of cargo and passengers, determined by weight, cubic displacement, and distance to be flown, that may be transported by specified aircraft

amb ambulance

ambl airmobile

ambt ambulatory

AMC Air Mobility Command; Army Materiel Command

AMCCOM (US Army) Armament Munitions and Chemical Command

AMCR Air Mobility Command Regulation

AMDF Army Master Data File

AMEDD Army Medical Department

ammo ammunition

amph amphibious

AMS anchor mooring system

anchorage a harbor, river, or offshore area that can accommodate a ship at anchor for quarantine, queuing, or discharge

ANSI American National Standards Institute

ANSI/ISO American National Standards Institute/ International Organization for Standardization

AOC airlift operations center

AP armor-piercing

APC armored personnel carrier

APOD aerial port of debarkation

APOE aerial port of embarkation

approx approximately

APU auxiliary power unit

AR Army regulation

ARINC Aeronautical Radio, Incorporated

armd armored

arrival airfield control group the organization that receives transported units from the Air Force carrier and controls them until released to their parent unit

arty artillery

ASE aircraft survivability equipment

ASG area support group

ASIOE Associated Support Item of Equipment

ASMP Army Strategic Mobility Plan/Program

ASP ammunition supply point

ASR alternate supply route

AT antitank

ATACMS Army Tactical Missile System

ATCOM United States Army Aviation Troop Command

ATMCT air terminal movement control teams

attn attention

auth authorized

AUTODIN automatic digital network

aux auxiliary

aval available

avdp avoirdupois

avg average

AVIM aviation intermediate maintenance

avn aviation

avoirdupois weight a system of weights and measures based on a pound containing 16 ounces or 7,000 grains and equal to 453.59 grams

AVUM aviation unit maintenance

AWR-3 Army War Reserve-3

backhaul shipment of material to or through an area from which the material had previously been shipped

back loading the act of loading outbound cargo on a semitrailer that delivered inbound cargo

BASE basic Army strategic estimates

BB break-bulk

bbl barrel

BC barge, cargo

BD battlefield distribution

bde brigade

BDL beach discharge lighter

berth designated area alongside a wharf or anchorage

BMU beachmaster unit

bn battalion

BOE Bureau of Explosives

BP boiling point

break-bulk to unload and distribute a portion or all of a shipment

brg bridge

C Celsius

CAA command arrangement agreement

cal caliber

cap capacity

cargo offering a requirement placed on a movement control authority by a shipping activity to obtain instructions for shipment of cargo

cargo transporter reusable, metal, shipping container designated for worldwide surface and air movement of supplies and equipment

cart cartridge

cav cavalry

CB center of balance

cbt combat

CDE chemical defense equipment

CDI cargo disposition instructions

cdr commander

CDS container delivery system

C-E communications-electronics

center of gravity the hub of all power and movement upon which everything depends; that characteristic, capability, or location from which enemy and friendly forces derive their freedom of action, physical strength, or the will to fight

CEOI communications-electronics operation instructions

CEWI combat electronic warfare intelligence

CF causeway ferry; convertible freighter

CFR Code of Federal Regulation

CG center of gravity

cgo cargo

CH cargo helicopter

chap chapter

CHAP/VUL CHAPARRAL/VULCAN

CHE cargo handling equipment

CHET commercial heavy equipment transporter

chg charge

CINC commander in chief

CINCCENT Commander in Chief, Central Command

Civil Reserve Air Fleet Civil air carriers of US registry that contractually commit themselves to provide personnel, services, and aircraft to support AMC under stated emergency conditions

CL centerline

close operations offensive or defensive operations where forces are in immediate contact with the enemy

co company

CODES computerized deployment system

COFC container-on-flatcar

C of E Corps of Engineers

combat service support the focus of logistics at the tactical level of war; the synchronization of essential functions, activities, and tasks necessary to sustain soldiers and their weapon systems in an area of operations; includes but is not limited to that support rendered by service support troops to arm, fuel, fix, move, man, and sustain soldiers and their equipment

combat zone that area required by combat forces for the conduct of operations forward of the army rear area boundary

COMINT communications intelligence

comm communication

commander's intent a concise expression of the purpose of an operation, a description of the desired end state, and the way in which the posture of that goal facilitates transition to future operations

common service that function performed by one military service in support of another military service for which reimbursement is not required from the service receiving support

common-user transportation a point-to-point transportation service managed by a single service for common use by two or more services or other authorized agencies for which reimbursement is normally required from the service or agency receiving support

communications zone the rear part of the theater of war or theater of operations that contains the lines of communication, theater logistic bases, forward operating bases, and other agencies required for the immediate support and maintenance of the field forces; extends back to the CONUS base

COMMZ communications zone

COMPASS Computerized Movement Planning and Status System

COMSEC communications security

CONEX container express

cont continued

container a reusable cargo container that is assigned a permanent control number; and container (for example, crate) packed with more than one shipment unit and assigned a one-time, container-control number according to Appendix B3, DOD Regulation 4500.32-R

container control activity an activity exercising overall administrative control of container service and the movement of cargo transporters to, from, and within a theater. This activity is assigned to the freight movement division of the movement control agency

container control officer a designated officer within an installation who receives and dispatches cargo transporters and who is responsible for control, efficient use, and report of cargo transporters at that installation. Said officer has custodial property responsibility for cargo transporters from the time received until he reports their dispatch

controlled route a route, the use of which is subject to traffic or movement restrictions

control point a position along a route of march at which men are stationed to give information and instructions for the regulation of supply of traffic

contr(s) container(s)

CONUS continental United States

coord coordination, coordinating

COR cargo outturn report

COSCOM corps support command

CP command post; checkpoint

CR curve resistance

CRAF Civil Reserve Air Fleet

CS combat support

CSA corps support area

CSR controlled supply rate; controlled supply route

CSS combat service support

CSSAMO CSS automation management offices

CS3 combat service support system

CTF commander, task force

C3I command, control, and communications integration

cu cubic

CUCV commercial utility cargo vehicle

CVA carrier, vertical assault

CWR calm water ramp

CZ combat zone

DA Department of the Army

DACG departure airfield control group

DAMMS-R Department of the Army Movement Management System-Redesigned

date shipped the date a shipment is released by the consignor to the carrier

DBP drawbar pull

DCD Directorate of Combat Developments

DCSLOG Deputy Chief of Staff for Logistics

DD Department (of) Defense (form)

DDC division data center

deml demolition

demobilization the act of returning the force and materiel to a premobilization posture or to some other approved posture; also involves returning the mobilized portion of the industrial base to peacetime conditions

density weight displacement of freight per cubic foot or other unit of volume

departure airfield control group the organization provided by the supported force that will control the deploying unit to be airlifted from the marshaling area until released to the TALCE at the ready line. Upon acceptance into DACG, all equipment belongs to the DACG commander until released to the Air Force. DACG functions are the same for any service that is being airlifted deployment the relocation of forces to desired areas of operations; the movement of forces within areas of operations

det detonating

DIA Defense Intelligence Agency

DIAM Defense Intelligence Agency Manual

DISCOM division support command

dispatch route a roadway over which full control, both as to priorities of use and regulation of movement of traffic in time and space, is exercised. A movement credit is required for its use by an independent vehicle or group of vehicles, regardless of number or type

distribution system that complex of facilities, installations, methods, and procedures designed to receive, store, maintain, distribute, and control the flow of military materiel between the point of receipt into the military system and the point of issue to using activities and units

div division

diversion the rerouting of cargo or passengers to a new transshipment point or destination or to a different mode of transportation before arrival at ultimate destination

DLA Defense Logistics Agency

DMA Defense Mapping Agency

DMAHTC Defense Mapping Agency Hydrographic/Topographic Center

DO director of operations

DOC Department of Commerce

doctrine fundamental principles by which military forces guide their actions in support of national objectives. Doctrine is authoritative but requires judgement in application

DOD Department of Defense

DOI Department of the Interior

DOT Department of Transportation

DPSC Defense Personnel Support Center

DS direct support

DSA division support area

DSN defense system network

DSU direct support unit

DTO division transportation office(r)

DTS Defense Transportation System

DTT destination truck terminal

DWT deadweight ton(nage)

DZ drop zone

ea each

EAC echelon above corps

EAT external air transport

ECCM electronic counter-countermeasures

EDSS equipment deployment and storage systems

elct electronics

elec electric

EM enlisted member

emerg emergency

eng engineer

EPW enemy prisoner of war

equip equipment

ETA estimated time of arrival

ETD estimated time of departure

ETR export traffic release

EXTAL extra time allowance

EZ extraction zone

F Fahrenheit

FA field artillery

FAW front axle weight (in pounds)

FC floating causeway; field circular

FCU fuel consumption unit

FLOFLO float-on/float-off

FLOT forward line of own troops

FM frequency modulated; field manual

FMS floating maintenance shop

FMTV Family of Medium Tactical Vehicles

FOH front overhang

force projection the movement of military forces from CONUS or a theater in response to requirements of war or operations other than war. Force projection operations extend from mobilization and deployment of forces, to redeployment to CONUS or home theater, to subsequent demobilization

FORSCOM (United States) Forces Command

FOS full operational status

4K RTFLT 4,000-pound capacity rough terrain forklift truck

frag fragmentation

FRAGO fragmentary order

frustrated cargo any shipment of supplies and/or equipment which, while en route to destination, is stopped before receipt and for which further disposition instructions must be obtained

FS floor station

FSS fast sealift ship

FSTC United States Army Foreign Science and Technology Center

ft foot, feet

ft/sec feet per second

FTRAC full-tracked vehicle

fwd forward

g gravity; unit of force

G3 general staff operations

G4 general staff supply

ga gauge

GAA grease, artillery, and automotive

gal gallon

GBL government bill of lading

GCA ground-controlled approach

gen general

GM guided missile

GMT Greenwich mean time

gp group

GP general purpose

GPM gallons per minute

GR grade resistance

gross weight for palletized cargo, total weight of the cargo, pallet, and tie-down equipment; for unpalletized cargo, the actual (scale) weight of the cargo

GS general support

GSA General Services Administration

GSU general support unit

GTL gross trailing load

h height

H & S hot and serve

hazardous materials any material that is flammable, corrosive, oxidative, explosive, toxic, radioactive, or unduly magnetic

HAZMAT hazardous materials

HCP health and comfort pack

HE high explosive

HEMAT heavy expanded ammunition trailer

HEMTT heavy expanded mobility tactical truck

HET heavy equipment transporter

hgt height

HHC headquarters and headquarters company

HHG household goods

HICHS Helicopter Internal Cargo Handling System

highway traffic headquarters headquarters exercising highway regulations to use highway transportation facilities and equipment most effectively according to assigned tasks.

Regulations provide guidance for planning, routing, scheduling, and directing actual use of the highways by vehicles, personnel afoot (including troops, refugees, and other civilians), and animals

HLPS heavy lift prepositioned ship

HMMWV high mobility multipurpose wheeled vehicle

HMMS HELLFIRE modern missile system

HN host nation

HNS host nation support

hosp hospital

host nation support civil and/or military assistance rendered by a nation to foreign forces within its territory during peacetime, times of crisis, emergencies, or war; assistance provided during war is based upon agreements mutually concluded between nations

how howitzer

HP horsepower

HQ headquarters

hr hour(s)

HRP highway regulation point

HTH highway traffic headquarters

hvy heavy

IAW in accordance with

IBS Integrated Booking System

ICC Interstate Commerce Commission

ICODES Improved Computerized Deployment System

IDA Institute of Defense Analysis

IFR instrument flight rules

imp imperial

imperial of or relating to the British Imperial System of weights and measures

in inch(es)

inf infantry

installation transportation officer a qualified individual appointed on competent orders to serve a military installation or activity that requires commercial transportation service. Said officer serves as a member of the technical staff of the commander of the activity to which assigned and as the point of contact between the installation or activity and the representative of the movement management system

INTACS Integrated Tactical Communications System

intel intelligence

intelligence the product resulting from collection, processing, integration, analysis, evaluation, and interpretation of available information concerning foreign countries or areas

intertheater shipments shipments that move into or out of the theater through water or aerial terminals

in-transit visibility the immediate availability of data pertaining to the location of materiel in-transit from the provider to the requester (from the factory to the foxhole)

intratheater shipments movements originating and terminating within the theater

IPDS inland petroleum distribution system

ISO International Standards Organization

ISU internal airlift/helicopter slingable container unit. The EDSS air dominant system certified for helicopter internal/external airlift, AMC aircraft, and combat off-load

ITO installation transportation office(r)

ITV in-transit visibility

IWW inland waterway

JLOTS joint logistics over the shore

JMC Joint Movement Center

JTB Joint Transportation Board

JTF joint task force

km kilometer(s)

KMIH kilometers in the hour

kn knot(s)

KPH kilometers per hour

kw kilowatt(s)

l liter(s)

LAPES low altitude parachute extraction system

LARC lighter, amphibious resupply cargo

LASH lighter aboard ship

lb pound(s)

LCC lighter control center

LCM landing craft, mechanized

LCU landing craft, utility

LE low explosive

liaison that contact or intercommunication maintained between elements of military forces to ensure mutual understanding and unity of purpose and action

LID light infantry division

liq liquid

LKA amphibious cargo ship[1]

LMSR large, medium-speed roll-on/roll-off vessel

LMTV Light Medium Tactical Vehicle

LO liaison officer

LOA length overall

load a grouping of vehicles, equipment, and/or passengers to be loaded into a specific aircraft

loading plan a document that presents in detail all instructions for the arrangements of personnel and equipment aboard a given aircraft or vessel; also serves as a manifest

LOC lines of communication

log logistics

LOGCAP Logistics Civil Augmentation Program

logistics the process of planning and executing the movement and sustainment of forces in the execution of military operations. Logistics includes the design, development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel; the acquisition, preparation, maintenance, equipping, movement, and health service support of personnel; the acquisition or furnishing of services; and the acquisition, construction, maintenance, operation, and disposition of facilities. Logistics is an overarching function that must encompass the range of military operations. At the tactical level, logistics focuses on the traditional CSS functions of arming, fixing, fueling, manning, moving, and sustaining soldiers

logistics base a principal or supplementary base of support; a locality containing installations that provide logistics or other support

logistics-over-the-shore operations the loading and unloading of ships without the benefit of fixed port facilities

LOGMARS Logistics Applications of Automated Marking and Reading Symbology

LOLO lift-on/lift-off

long ton a unit of ship capacity or weight equal to 2,240 pounds

LOTS logistics over the shore

LRP long range patrol

LS loadmaster station

LSD landing ship, dock

LST landing ship, tank

LSV logistics support vessel

lt light

LT large tug; lieutenant

LTON long ton

LVAD low velocity air drop

LVTP landing vehicle, track, personnel

LWL load waterline

LZ landing zone

m meter(s)

m/sec meters per second

MA marshalling area

MAB mobile floating assault bridge-ferry (US)

MACOM major Army command

mag magazine

maint maintenance

MAP Military Assistance Program

MARAD Maritime Administration

MATCO Military Air Traffic Coordination Office

materials-handling equipment mechanical devices for handling supplies with greater ease and economy. Examples include forklifts, roller conveyors, and loaders

materiel management the supervision of supplies and equipment throughout strategic-, operational-, and tactical-level areas of operation

max maximum

MC movement control

MCA movement control agency

MCC movement control center

MCO movement control officer

MCT movement control team

mdm medium

mech mechanized

MED Mediterranean

MEDDAC medical department activity

METL mission-essential task list

metric ton a unit of internal capacity for ships equal to 100 cubic feet

METT-T mission, enemy, troops, terrain and weather, and time available

mg machine gun

mgt management

MHE materials-handling equipment

mi mile

MIH miles in the hour

Military Road Maneuver Network the road system required by a commander for conducting a specific operation and for the required logistical support of that operation. It is defined and controlled (allotment of maneuver credits) by the military authorities, national or allied, according to the breakdown of responsibilities in the theater of operations

Military Road Network includes all routes designated in peacetime by the host nations to meet anticipated military movements and transport movements, both allied and national

Military Sealift Command the single-manager of ocean transportation to provide, under one authority, the control, operation, and administration of sealift for personnel, mail, and cargo of DOD; operates as a TCC of the USTRANSCOM (formerly Military Sea Transportation Service)

military terminal any water or aerial port of embarkation operated by or for a military department as a terminal facility for receiving, loading, unloading, and forwarding military personnel or property. This term includes commercial terminals where activities are conducted under the guidance of the military

Military Traffic Management Command the jointly staffed, industrially funded major Army command, serving as the DOD single-manager operating agency for military traffic, land transportation, and common-user ocean terminal service; operates as a TCC of the USTRANSCOM

MILSTAMP Military Standard Transportation and Movement Procedures

MIL-STD military standard

MILSTRIP Military Standard Requisitioning and Issue Procedures

MILVAN military-owned demountable container

MIN minute

mk mark

ml milliliter(s)

MLB metallic link belt

MLRS multiple launch rocket system

MLW mean lower water

mm millimeter(s)

MMC Materiel Management Center

M973/A1 carrier, cargo tracked, 1 1/2 ton

mo month(s)

mobilization the process by which the Armed Forces or a portion thereof is brought to a state of readiness for war or other national emergency; includes activating all or part of the RC, as well as assembling and organizing personnel, supplies, and materiel

MOGAS motor gasoline

mole a structure with a breakwater on one side and a loading/unloading facility on the other

movement control the planning, routing, scheduling, and controlling of personnel and supply movements over LOCs; also, an organization responsible for these functions

MOVEPLAN Military Application Program Package

MP military police

MPH miles per hour

MRC manpower requirements criteria

MRE meal, ready-to-eat

MRP movement regulating point

MRS Mobility Requirements Study

MRT movement regulating team

MSB main support battalion

MSC Military Sealift Command

MSR main supply route

MST maintenance support team

mtd mounted

MTMC Military Traffic Management Command

MTMCTEA Military Traffic Management Command Transportation Engineering Agency

MTON measurement ton

MTP motor transport plan/planning

MTV medium tactical vehicle

NA not applicable

nautical mile international unit equal to 6076.11549 feet or 1,852 meters

NATO North Atlantic Treaty Organization

Navaid radio-navigation

NBC nuclear, biological, chemical

NCO noncommissioned officer

NCOIC noncommissioned officer in charge

NDRF National Defense Reserve Fleet

NDT net division tonnage

NEA Northeast Asia

NICAD nickel cadmium

NM nautical mile

no number

NSN national stock number

NSP non-self-propelled

NT number of passing tracks

NTL net trainload

OB route obstruction

OD olive drab

off offensive

OG olive green

OIC officer in charge

op operator, operations, operating

OPCON operational control

operations other than war military activities during peacetime and conflict that do not necessarily involve armed clashes between two organized forces

OPLAN operations plan

OPORD operation order

OPSEC operations security

ORP ocean reception point

OTT origin truck terminal

outsize cargo cargo that exceeds the capabilities of the C-141B aircraft and requires the use of a C-5A/B

OVE on-vehicle equipment

oversize cargo any single item that exceeds any one of the following dimensions: 104 inches long, 84 inches wide, and 96 inches high, and will not fit on a 463L pallet

oz ounce(s)

pallet, 463L a flat base (platform) used for combining cargo, equipment, or a single load item to facilitate the storing, handling, and air transporting of these items with the Air Force 463L materials-handling system

pax passengers

PD point detonating

perc percussion

pers personnel

pier a structure that projects from the shoreline to accommodate ships in discharge and loading. Often both sides are designed to receive ships

PLL prescribed load list

PLS palletized load system

PM provost marshal

PND Ports for National Defense

PNL prescribed nuclear load

POC point of contact

POD point of debarkation

POE point of embarkation

POL petroleum, oils, and lubricants

port of debarkation an aerial or seaport within the theater of operations where the strategic transportation of forces is completed; it may not be the force's final destination

port of embarkation an air or sea terminal at which troops, units, military-sponsored personnel, unit equipment, and materiel are boarded or loaded

port support activity a flexible support organization composed of mobilization station assets that ensures the equipment of deploying units is ready to load. The PSA operates unique equipment in conjunction with ship loading operations and is controlled by the military port commander

POV privately owned vehicle

POW prisoner of war

PP&O plans, programs, and operations

prct practice

PREPO prepositioned

prop propelling

PSA port support activity

psi pounds per square inch

pst pass time

pt point

PZ pickup zone

qt quart

qty quantity

QUADCON quadruple container. The EDSS ground dominant system used by units to deploy by sea. The primary surface/sea deployment system

quay a structure running parallel to the shoreline used to accommodate ships for discharge and loading

RAW rear axle weight (in pounds)

R/CW ration, cold weather

RC Reserve Component

rd rounds

RDD required delivery date

RDL reference datum line

Ready Reserve Force quick response ships in the National Defense Reserve Fleet, maintained in a high state of readiness by the Maritime Administration for activation in 5, 10, or 20 days. Part of the MSC program

receiving transportation officer the transportation officer serving the ultimate consignee

ref reference

REFORGER return of forces to Germany

refrig refrigerated

report of shipment notification by the shipper to the consignee that a specific shipment is en route

REPSHIP report of shipment

reserved route a route, the use of which is allocated exclusively to a particular authority or formation, or that is intended to meet a particular requirement

RLT rolling liquid transporter

ROH rear overhang

RORO roll-on/roll-off

ROS reduced operational status

route the prescribed course to be traveled from a specific point of origin to a specific destination

RP release point

RR rolling resistance

RRDF roll-on/roll-off discharge facility

RRF Ready Reserve Force

RT running time

RTCC rough terrain container crane

RTCH rough-terrain container handler

RTFLT rough terrain forklift truck

RWI radio and wire integration

S1 Adjutant (US Army)

S2 Intelligence Officer (US Army)

S3 Operations and Training Officer (US Army)

S4 Supply Officer (US Army)

/s/ signed

SB support base; supply bulletin

S&P stake and platform

SEABEE sea barge

sec second

SECDEF Secretary of Defense

SEDRE Sea Emergency Deployment Readiness Exercise

SF standard form

SGM sergeant(s) major

short ton a unit of ship capacity or weight equal to 2,000 pounds

6K VRRTFLT 6,000-pound capacity variable reach rough terrain forklift truck

SLWT side loadable warping tug

SM speedometer multiplier

SOI signal operating instruction(s)

SOP standing operating procedure

SP start point; self-propelled

special cargo cargo that requires special handling or protection, such as pyrotechnics or precision instruments

SPOD seaport of debarkation

SPOE seaport of embarkation

spotting the placing of trailers, container transporters, or railcars where required to be loaded or unloaded

sq square

SRC Standard Requirements Code

SST system support team

S&T supply and transport

STANAG standardization agreement

statute mile unit of distance equal to 5,280 feet (1,760 yards or 1.609 kilometers)

std standard

stlr semitrailer

st mi statute mile

STON short ton

stor storage

strategic airlift the continuous or sustained movement of units, personnel, and materiel in support of all DOD agencies between area commands or between CONUS and overseas areas. Strategic airlift resources have the capability to airland or airdrop troops, supplies, and equipment for augmentation of tactical forces when required

strategic mobility the capability to deploy and sustain military forces worldwide in support of national strategy; transportation actions using national assets, both military and civilian, in support of a force projection mission

strategic sealift the afloat prepositioning and ocean movement of military materiel in support of US and Allied forces or other government-sponsored materiel deemed in the national interest. Strategic sealift includes both government owned and commercially acquired assets (US and foreign flag) and associated shipping services

strategy the art and science of employing the armed forces and other elements of national power during peace, conflict, and war to secure national security objectives

sup supply

supervised route a roadway over which control is exercised by a traffic control authority by means of traffic control posts, traffic patrols, or both. A movement credit is required for its use by a column of 10 or more vehicles or by any vehicle of exceptional size or weight

SUSV small unit support vehicle

svc service, servicing

SWA Southwest Asia

/t/ typed

T ton

TA theater army

TAACOM theater army area command

T-ACS auxiliary crane ship [2]

T-AKR auxiliary cargo, roll on/roll off [2]

TALCE tanker airlift control element

tanker airlift control element a deployed element of an Air Force airlift control squadron. A composite organization tailored to support airlift missions transiting locations where C2, mission reporting, or support functions, are nonexistent or require augmentation

TAV total asset visibility

TB technical bulletin

TC training circular

TCC transportation component command

TCMD Transportation Control And Movement Document

TCN transportation control number

TD train density

TDA table(s) of distribution and allowances

TD2 double track TD

TDY temporary duty

TE tractive effort

tk tank

tlr trailer

TM technical manual

TMCA theater movement control agency

TMO transportation movement office(r)

TMR transportation movement release

TMT transportation motor transport

TNT trinitrotoluene

TOE table(s) of organization and equipment

TOFC trailer-on-flatcar

Ton-miles a unit of measure expressed in number of STONs moved over a specific distance in miles

total asset visibility the immediate availability of data pertaining to the location of materiel in storage or in transit from the provider to the requester

TOW tube-launched, optically tracked, wire-guided missile

TP transportation priority

TPFDD time-phased force and deployment data

trac tractor

tracing the act of requesting the location of a shipment to expedite its movement or to establish delivery time

traffic control post point on the highway where the military police enforce highway traffic control and furnish information and directions

trans transportation; transporter

TRANSCOM transportation command

transportation control and movement document the basic cargo movement document containing the information necessary to make movement management decisions through the worldwide DOD transportation system

transportation movement office an office designed to coordinate all movements to be carried out and to ensure maximum use of available resources. These movement offices are assigned to the communications zone, the field army, and the corps support brigade

transportation movement release shipping instructions issued by a movement control authority in response to a cargo offering

transportation officer the person appointed or designated by the commander of a military activity to perform transportation services and movement management at a district, base, installation, or activity. This term also applies to movement management officers

trk truck

trl trailer

TRS transportation railway service

TSM terminal support module

TT terminal time; truck terminal

TTP terminal transfer point; trailer transfer point

TTU transportation terminal unit

TVAR task vehicle availability rate

UH utility helicopter

UMO unit movement officer

unit loading the loading of troop units with their equipment and supplies in the same ship, aircraft, or land vehicle

URS unit reference sheet

US United States

USACASCOM United States Army Combined Arms Support Command

USAF United States Air Force

USARSO US Army, South

USCG United States Coast Guard

USCINCTRANSCOM Commander in Chief, United States Transportation Command

USMC United States Marine Corps

USN United States Navy

USNS United States Naval ship (civilian manned)

USTRANSCOM United States Transportation Command

util utility

VA Virginia

veh vehicle

VPH vehicles per hour
VPK vehicles per kilometer
VPM vehicles per mile
VSF vessel stowage factor
w width
w/ with
w/b webbed belt
WB wheelbase
wgt weight
wharf a general term for mole, pier, or quay
whl wheeled
wkr wrecker
w/o without
wown without winch
WP white phosphorous
WPOD water port of debarkation
WPS Worldwide Port System
WR washroom
wt weight
WTCA water terminal clearance authority
ww with winch
yd yard
y year
Z Zulu Time; Greenwich Mean Time
ZT zone time

[1] Navy category code for specific type of vessel (supports Navy/Marine amphibious operation)
[2] Managed and operated by Military Sealift Command

REFERENCES

SOURCES USED

These are the sources quoted or paraphrased in this publication.

AAFES Exchange Service Regulation 8-4. Emergency Operations. March 1993.

AMCR 3-3. Combat Control Team Operations. 10 May 1992.

AMCR 55-47. C-130 Configuration/Mission Planning. 29 December 1989.

AMCR 55-141. C-141 Strategic Airlift Operations. 1 June 1992.

AR 55-355. Defense Traffic Management Regulation. 31 July 1986.

AR 380-5. Department of the Army Information Security Program. 25 February 1988.

AR 385-40. Accident Reporting and Records. 1 November 1994.

BOE Pamphlet 6C. Intermodal Loading Guide for Products in Closed Trailers and Containers. July 1995.[1]

BOE Tariff No BOE-6000-P. 29 May 1996.[1]

DIAM 57-2. Guide to Computing Port Throughput Capacity. May 1996.

DOD Pub 4500.32-R, Volume 1. Military Standard Transportation and Movement Procedures (MILSTAMP). 15 Mar 1987.

FM 5-446. Military Nonstandard Fixed Bridging. 3 June 1991.

FM 10-52. Water Supply in Theaters of Operations. 11 July 1990.

FM 55-9. Unit Air Movement Planning. 5 April 1993.

FM 55-10. Movement Control in a Theater of Operations. 8 December 1992.

FM 55-17. Terminal Operations Coordinator's Handbook. 9 September 1990.

FM 55-20. Army Rail Transport Units and Operations. 31 October 1986.

FM 55-50. Army Water Transport Operations. 30 September 1993.

FM 55-60. Army Terminal Operations. 15 April 1996.

FM 55-65. Strategic Deployment. 3 October 1995.

FM 55-450-3. Multiservice Helicopter External Air Transport: Basic Operations and Equipment. 11 February 1991.

FM 55-450-4. Multiservice Helicopter External Air Transport: Single-Point Rigging Procedures. 11 February 1991.

FM 55-450-5. Multiservice Helicopter External Air Transport: Dual-Point Load Rigging Procedures. 11 February 1991.

FM 101-10-1/1. Staff Officers Field Manual – Organizational, Technical and Logistical Data (Volume 1). 7 October 1987.

FM 101-10-1/2. Staff Officers Field Manual – Organizational, Technical, and Logistical Data, Planning Factors (Volume 2). 7 October 1987.

49 CFR. Transportation. 1 October 1994.[2]

GATX Tank Car Manual. 1994.[3]

General Rules Governing the Loading of Commodities on Open-Top Cars (Section 6). AAR. April 1993.

Guide to Port Entry. 1995/96.[4]

Janes World Railways. 1995/96.

MSC-P504, Ship Register.[5]

MIL-STD 129. Marking for Shipment and Storage. 25 September 1984.[2]

MTMCTEA Report SE90-3d-50. Port Operational Performance Simulator (POPS). August 1990.[6]

Redeployment and Port Operations, Leader's Safety Guide. March 1991.

Sailing Directions Fleet Guides.[7]

SB 710-2. Supply Control Combat Consumption Rates for Ground and Aviation Type Petroleum Products. 12 March 1993.

STANAG 1059. Distinguishing Letters for Geographic Entities for Use in NATO. 7 June 1995.

STANAG 2002. Warning Signs for the Marking of Contaminated or Dangerous Land Areas, Complete Equipment, Supplies, and Stores. 26 November 1980.

STANAG 2027. Marking of Military Vehicles. 18 December 1975.

STANAG 2174. Military Routes and Route/Road Networks. 25 February 1994.

TB 55-46-1. Standard Characteristics (Dimensions, Weight, and Cube) for Transportability of Military Vehicles and Other Outsize/Overweight Equipment (in TOE Line Item Number Sequence). 1 January 1995.

The Official Railway Equipment Register. April 1996.

TM 9-1300-206. Ammunition and Explosives Standards. 30 August 1973.

TM 55-204. Maintenance of Railroad Way and Structures. 29 June 1966.

TM 55-602. Movement of Special Freight. 12 May 1971.

TM 55-2200-001-12. Transportability Guidance for Application of Blocking, Bracing and Tiedown Materials for Rail Transport. 31 May 1978.

United States Code. Sections 831 through 835, Title 18, Chapter 39, Explosives and Other Dangerous Articles.

UTLX Tank Car Manual. 1994.[8]

World Port Index Pub 150.[7]

DOCUMENTS NEEDED

These documents should be available to the intended users of this publication.

DA Form 1594. Daily Staff Journal of Duty Officer's Log. November 1962.

DA Form 1711-R. Engineer Reconnaissance Report. May 1985.

DD Form 1265. Request for Convoy Clearance. January 1959.

DD Form 1266. Request for Special Hauling Permit. January 1959.

DD Form 1384. Transportation Control and Movement Document. April 1966.

DD Form 1610. Request and Authorization for TDY Travel of DOD Personnel. June 1967.

SF 361. Transportation Discrepancy Report. March 1984.

READINGS RECOMMENDED

These readings contain relevant supplemental information.

FM 1-100. Doctrinal Principles for Army Aviation in Combat Operations. 28 February 1989.

FM 1-101. Aviation Battlefield Survivability. 5 December 1990.

FM 1-111. Aviation Brigades. 27 August 1990.

FM 1-120. Army Air Traffic Services Contingency and Combat Zone Operations. 22 May 1995.

FM 1-300. Flight Operations Procedures. 22 June 1993.

FM 5-36. Route Reconnaissance and Classification. 10 May 1985.

FM 10-27. General Supply in Theaters of Operations. 20 April 1993.

FM 10-69. Petroleum Supply Point Equipment and Operations. 22 October 1986.

FM 55-1. Transportation Operations. 3 October 1995.

FM 55-2. Division Transportation Operations. 31 January 1985.

FM 55-9. Unit Air Movement Planning. 5 April 1993.

FM 55-12. Movement of Units in Air Force Aircraft. 10 November 1989.

FM 55-30. Army Motor Transport Units and Operations. 27 June 1997.

FM 55-312. Military Convoy Operations in the Continental United States. 3 April 1991.

FM 63-3. Corps Support Command. 30 September 1993.

FM 71-100. Division Operations. 16 June 1990.

FM 100-5. Operations. 14 June 1993.

FM 100-10. Combat Service Support. 3 October 1995.

FM 100-17-1. Army Prepositioned Afloat. 19 July 1996.

SB 10-495. Standard "B" Ration for the Armed Forces. 29 November 1984.

STANAG 2029. Method of Describing Ground Locations, Areas and Boundaries. 23 October 1989.

TB 55-46-1. Standard Characteristics (Dimensions, Weight, and Cube) for Transportability of Military Vehicles and Other Outsize/Overweight Equipment (in TOE Line Item Number Sequence). 1 January 1995.

TC 1-115. Medium Helicopter Battalion. 29 September 1988.

TM 5-370. Railroad Construction. 1 September 1970.

TM 38-250. Preparing Hazardous Materials for Military Air Shipments. 25 November 1994.

TM 55-1520-400-14. Transportability Guidance: Marine Transport of US Army Helicopter. 28 April 1978.

PROJECTED PUBLICATIONS

The following publication is scheduled for publication and will supercede FM 5-36, Route Reconnaissance and Classification, 10 May 1985:

FM 5-170. Route Reconnaissance and Classification.

[1] Available from:
Association of American Railroads
Bureau of Explosives
50F Street NW
Washington, DC 20001
COM 202-639-2222

[2] Available from:
US Government Printing Office
Superintendent of Documents
Mail Stop: SSOP
Washington, DC 20402-9328

[3] Available from:
General American Transportation Corporation
120 South Riverside Plaza
Chicago, IL 60606
COM 312-621-6200

[4] Available from:
Shipping Guides Ltd
Shipping Guides House
75 Bell Street
Reigate, Surrey RH2 7AN
England
COM 01737-242255/242256
FAX: 01737-222449

[5] Available from:
Commander, Military Sealift Command (COMSC)
Washington DC 20398-5100; or,
Requirements and Analysis Branch (N3113)
DSN 288-0087/0092. COM 202-433-0087/0092

[6] Available from:
Military Traffic Management Command
Transportation Engineering Agency
720 Thimble Shoals Boulevard, Suite 130
Newport News, VA 23606-2574
1-800-722-0727

[7] To receive these and other DMA publications, and to be placed on the Notice to Mariners mailing list to receive updated publications, contact:
Defense Mapping Agency
Navigation Information and Services
ST D 44 (ATTN: Mark Ford)
4600 Sangamore Road
Bethesda, MD 20816-5003
DSN 287-3183; COM 301-227-3181
E-mail: SDPUBS@dma.gov

[8] Available from:
Union Tank Car Company
111 West Jackson Blvd
Chicago, IL 60604
COM 312-431-5062

INDEX

By Order of the Secretary of the Army:

DENNIS J. REIMER
General, United States Army
Chief of Staff

Official:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army
03919

DISTRIBUTION:

Active Army, Army National Guard, and US Army Reserve: To be distributed in accordance with the initial distribution number 110390, requirements for FM 55-15.