I

ERGONOMIC DATA FOR SHIPBOARD SPACE DESIGN IN NATO SURFACE SHIPS

This ANEP belongs to a series of ANEP's that were prepared by AC/141(IEG/6)SG/8 On the Influence of Human Factors on Ship Design. These ANEP's cover Human Factors/Ergonomics issues pertaining to manning, automation, maintenance, habitability, environment, work space design, etc.

ANEP-26

NORTH ATLANTIC TREATY ORGANIZATION

MILITARY AGENCY FOR STANDARDIZATION (MAS)

NATO LETTER OF PROMULGATION

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E. STAI
Major-General, NOAF
Chairman

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RECORD OF CHANGES

CHANGE DATE	DATE ENTERED	EFFECTIVE DATE	BY WHOM ENTERED

PREFACE

1. The purpose of this document is to establish guidelines for the design of all shipboard spaces including continuously manned spaces, occasionally manned spaces, access spaces and accommodation. It also includes some ergonomic aspects of panel design.

2. This Allied Naval Engineering Publication, ANEP-26, has been prepared by IEG/6 Sub-Group 8 ON THE INFLUENCE OF HUMAN FACTORS ON SHIP DESIGN.

3. Each nation is encouraged to use this ANEP in its own design in order to provide a basis for evaluation of its designs by other countries, e.g. for the purposes of procurement decisions.

4. This ANEP is part of the ANEP Series On Human Factors/Ergonomics in Ship Weapon System Life Cycle which includes issues related to WSLC management, personnel, planning, automation, selection and training, material design, shipboard organization and procedures. The covering document of the series, ANEP-20, HUMAN FACTORS/ERGONOMICS IN THE DEVELOPMENT AND ACQUISITION OF SHIP WEAPON SYSTEMS, describes the intention of the ANEP series and the interrelationships between the various issues, as well as providing a full list of the ANEP's, together with a summary of each.

5. The anthropometric data are related to a Northern European male user population.
It is emphasized that anthropometric data of user populations will vary and are subject to change over time. The data provided in this ANEP should be regarded as minimal figures for the Northern European user population because it is most likely that human physical dimensions will increase over time. It will be necessary for designers to use figures relevant to the operational dates of warships in question. Also the consequences of a mixed crew is to be taken into account.

Some reports with anthropometric data are listed below:

Annuario di Statistica. Issued by: Instituto Nazionale di Statistica.

Brekelmans, F.E.M., Moonen, P.I.L., and Osinga, D.S.C. (1986). Anthropometric survey of army-men (Dutchmil '85; in Dutch). Report IZF 1986-27. Institute for Perception TNO, Soesterberg.

Jenkins, P.B., Pethybridge, R.J., and Hooper, R.H. (1990). An anthropometric survey of 367 Royal Naval Airmen 1987/88. Report 7/90. Institute of Naval Medicine, Gosports, Hants, United Kingdom.

Jenkins, P.B., and Pethybridge, R.J. (1990). An anthropometric survey of 361 Royal Marines 1989. INM Report 14/90. Institute of Naval Medicine, Gosports, United Kingdom.

Jenkins, P.B., and Pethybridge, R.J. (1990). An anthropometric survey of 136 personnel of the WRNS 1986/90. INM Report 15/90. Institute of Naval Medicine, Gosports, United Kingdom.

Jenkins, P.B., Pethybridge, R.J., and Hooper, R.H. (1990). An anthropometric survey of 431 Royal Naval Submariners 1986 - 1990. INM Report 17/90.

Jenkins, P.B., Pethybridge, R.J., and Hooper, R.H. (1990). An anthropometric survey of 1333 Royal Naval Personnel 1986 - 1990. INM Report 18/90. Institute of Naval Medicine, Gosports, United Kingdom.

Küchmeister, G., Helbig, K., and Jürgens, H.W. (1990). Körpermasse 18-40 jähriger Männer. Report Dok/BW/0050/82 (in german). By: DOKFIZBw, Bonn.

MilStandard 1472D; (1989). Human engineering design criteria for military systems, equipment and facilities. Department of Defence, Washington DC.

6. The ergonomic data as given in ANEP-24 (guidelines for shipboard habitability requirements for combatant surface ships) have been based on the ergonomic data as presented in this ANEP.
In that respect ANEP-26 must be considered as the leading document.

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Chapter 1 - INTRODUCTION

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1.1 General.

The presentation of complex data on human characteristics is a frequent problem in the development of Ergonomic design guides. Ergonomic data are invariably complex, for example an accurate description of the reach envelope of the human operator. Such complication is not required by the users of standards, however, who in most cases are not sufficiently knowledgeable to interpret detailed data. A compromise must therefore be achieved between the elaboration necessary for accuracy, and the simplicity necessary for an easily used standard.

Following from the above, human engineering standards are design guides and tend, typically, to be user based: they provide data describing human limitations. In contrast engineering standards are written in terms of hardware.

In addition it is obvious that there is a wide range of user anthropometry in the different Nato countries, as well as considerable differences with respect to habitability philosophy (e.g. accomodation, feeding) and different national military and industrial design/construction standards.
Consequently it is impossible in this guideline to state figures for design and construction that can be agreed on by all Nato countries. In an actual bi- or multilateral development and procurement program such figures have to be determined by the participating nation.

For reasons of consistancy the space dimensions as indicated in this ANEP have been based on the Northern European male user population.

Modification of the presented ergonomic data may be necessary in accordance with the actual anthropometric data.
Also the presence of female crew members should be taken into account, if necessary.
The presented ergonomic data should be used as starting points for negotiations aiming at determining the final figures. The determination of the dimensions should preferably be done with the assistance of a human factors ergonomic expert.

1.2 Basic recommendations.

1.2.1 Workplaces.
Ideal workplace design should be compatible both with the expected user and with systems performance requirements. The workplace envelope must be compatible with the anthropometric dimensions of the person who will be using the proposed equipment. The size and shape of the workspace will obviously depend directly on the size and shape of the person in the appropriate working posture.

Dimensions of the largest user of the population should be used for determining clearances, while dimensions of the smallest person should be used to determine limits of reach. This means that the human body must be kept in mind from the earliest conception of the workplace.

Operator-related dimensional factors that influence workplace configurations are:

(i) Eye position with respect to display area and/or field of view
(ii) Reach envelope of arms and legs
(iii) Manner and position of human body support
(iv) Clearance is important for access to and from the workplace and equipment.

1.2.2 Equipment station.
Equipment stations are designed for seated or standing operations or for combined "sit-stand" operations. Guidelines for the selection of the type of workplace are given in Figure 1.2.2.

Figure 1.2.2: Choice of Workplace by Task Variables.

Parameters	Heavy Load and/or Forces	Intermittent Work	Extended Work Envelope	Variable Tasks	Variable Surface Height	Repetitive Movements	Visual Attention	Fine Manipulation	Duration > 4 Hours
Heavy Load and/or Forces		ST	ST	ST	ST	S/ST	S/ST	S/ST	ST/C
Intermittent Work			ST	ST	ST	S / S/ST	S / S/ST	S / S/ST	S / S/ST
Extended Work Envelope				ST	ST	S/ST	S/ST	S/ST	ST/C
Variable Tasks					ST	S/ST	S/ST	S/ST	ST/C
Variable Surface Height						S	S	S	S
Repetitive Movements							S	S	S
Visual Attention								S	S
Fine Manipulation									S
Duration > 4 Hours									

Note: S = sitting; ST = standing; S/ST = sit/stand (an alternative to standing all day; a standing workplace could be used but would not be the preferred choice); ST/C = standing, with chair available.

Both job and workplace characteristics are looked at, at the same time, in relation to the preferred workplace choice; sitting, standing, sit/stand, or standing with a chair provided. More than one type of workplace may be acceptable for these task combinations; the most appropriate choice is indicated.

By the selection of chairs and their position relative to the worksurface, people should be given as much freedom as possible to change posture. Critical dimensional factors in developing the seated operator station include:

(i) Proper eye position relative to the viewing tasks, either on the console or the surrounding environment
(ii) Seat height, depth, and back angle with proper posture control
(iii) Leg and knee clearance
(iv) Hand and/or foot reach requirements for control action.

1.2.3 Control/display panels.
The size and arrangement of the display field should be adapted to the field of view and to the eye and head movements of the operator.

Chapter 2 - HUMAN BODY CHARACTERISTICS

2.1 Human body dimensions.

2.1.1 General.

The anthropometric characteristics of the user population have to be determined for any project. This chapter gives, as an example, some anthropometric data for northern European men between 18 and 40 years, based on measurements taken in 1988-1989. The dimensions in chapter 3 to 10 are based on Table 2.1.2 unless stated otherwise.

For the population of some countries it is known that the secular growth shift of men during the last 30 years has been rather spectacular. For designing a product with a long lifetime it is important that the growth shift is taken into account.

2.1.2 Human body dimensions, nude.
Selected dimensions of the human body suitable for initial design of crew space and equipment.

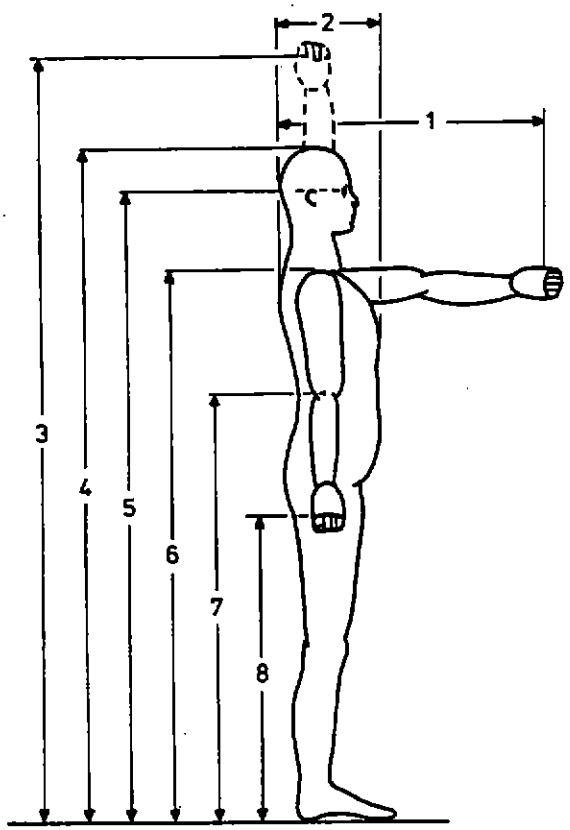
Table 2.1.2: Body dimensions and clothing additions for northern European men (nude). The 1st and 5th percentile are based on a database of 26-40 year old men; the 95th and 99th percentile are of 18-19 year old men.

		Percentiles and dimensions (mm) for northern European men (nude)				Addition for light and heavy clothing		
Nr.	Body dimension	1	5	95	99	garment	light	heavy
1	Horizontal reach (grip)	666	683	821	830	b	5	25
2	Chest depth	209	215	335	365	b	5	50
3	Vertical reach (grip)	1935	1990	2280	2356	d	35	35
4	Stature [1]	1625	1675	1933	1956	a + d	55	70
5	Eye height [1][2]	1495	1532	1796	1832	d	35	35
6	Shoulder height [1]	1317	1370	1588	1635	b + d	40	50
7	Elbow height [1]	1022	1041	1205	1240	d	35	35
8	Hand height (grip)	709	737	873	894	d	35	35
9	Hip breadth (standing)	314	318	382	395	b + c	10	60
10	Shoulder breadth	388	421	527	548	b	5	50
11	Sitting height [3]	848	870	996	1027	a + c	25	45
12	Eye hgt. sitting [2][3]	722	742	875	908	c	5	10
13	Elbow hgt. sitting [3]	184	195	284	296	b + c	5	10
14	Popliteal height [4]	400	419	510	528	d	35	35
15	Elbow-grip length	322	329	396	407	b	5	25
16	Buttock-poplit. length	449	465	559	588	b + c	5	15
17	Buttock-knee length	552	563	659	684	b + c	5	35
18	Buttock-foot length	953	973	1149	1170	b + d	40	60
19	Thigh thickness	119	126	171	183	c	5	15
20	Elbow-to-elbow width	379	390	547	561	b + c	25	130
21	Hip breadth sitting	293	308	413	434	b + c	10	66

[1] relaxed posture = - 2%
[2] relaxed head position = - 30 mm
[3] relaxed posture = - 4%
[4] seat height = - 20 mm

a = cap (light) or helmet (heavy)
b = coat
c = trousers
d = boots

Please take note that increments must be added for personal equipment such as a headset, oxygenmask.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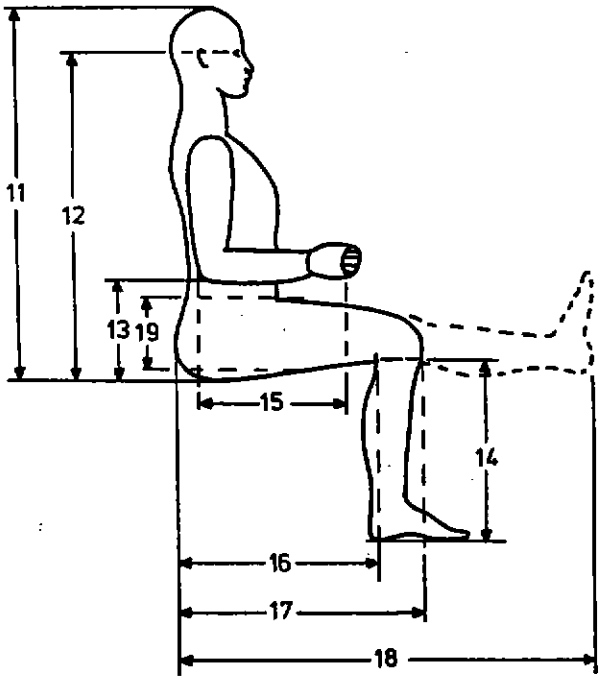
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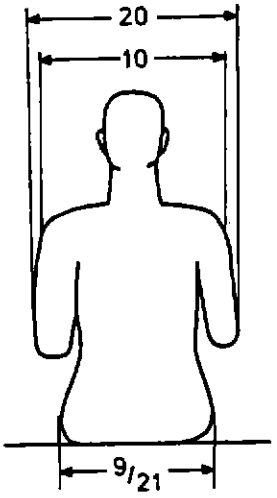
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2.1.3 Clothing increments.
When applying the body dimensions, increments must be added to the data to account for the effects of clothing.
Two dimensions are frequently provided, those of "light clothing" and "heavy clothing".
Light clothing includes normal work dress, flash protective clothing. Heavy clothing includes cold weather, foul weather, and protective clothing.

The increments for boots and head dress are:

Boots	: 35 mm
Helmets	: 35 mm
Sailor cap	: 10 mm
Forage cap	: 20 mm

The increments for clothing, boots and head dress are given in Table 2.1.2 and have to be added to the nude body dimensions; they are already implemented in the guidelines of chapters 3 to 10.

2.1.4 Designing for both men and women.
Designing for men and women means a combination of male and female databases: Using a male database from 1 to 99 percentile accomodates not more than 70 percent of the female user population.

2.1.5 Design limits.
The aim of any design should be to accomodate 100% of the selected population.
If design limits have to be introduced, the first step should be to accomodate the 1st to 99th percentile of the population; the mimimum is to accomodate the 5th to 95th percentile of the population.

2.1.6 Limiting body dimensions.
In designing a work place the physical dimensions of both the small and the tall people from the population have to be taken in account. Some work place dimensions are determined by the smaller, others by the taller people.
Some limiting factors are illustrated in Fig. 2.1.6.

The body dimensions of small people (1st-5th percentile) set the limits for:
- reach
- seat height
- line of sight

The body dimensions of tall people (95th-99th percentile) set the limits for:
- clearances (height, width, leg room, safety distance)
- lengths (berth)

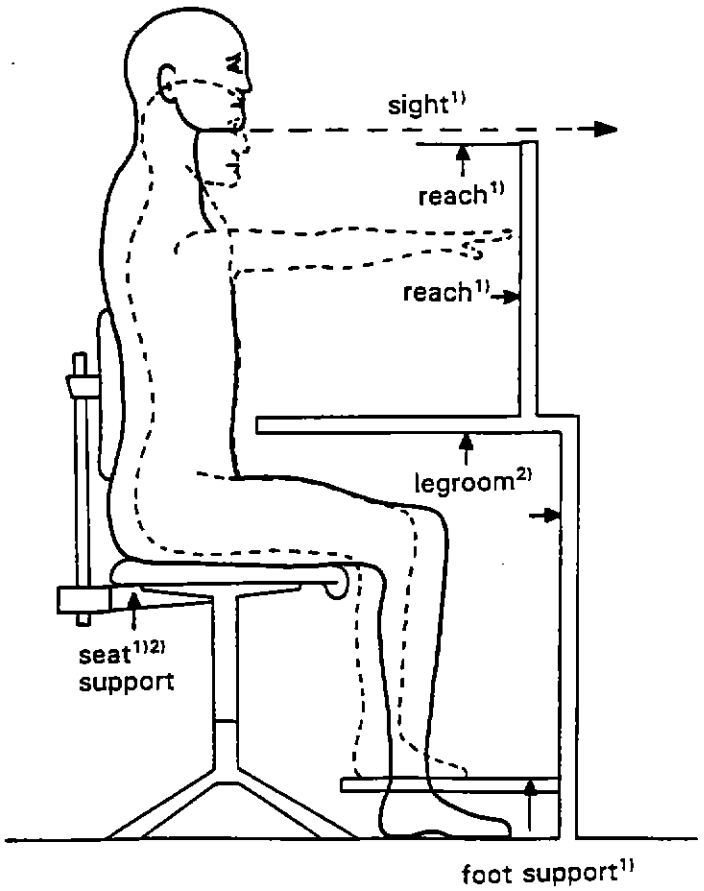

Fig. 2.1.6: Some limiting factors related to body size.
[1]) = limiting factor because of small people
[2]) = limiting factor because of tall people.

In practice it is often possible to take into account both the limiting factors of the small and tall people. For example:
A berth that is long enough and a door opening that has sufficient height for the tallest person, will also fit the smallest. Controls mounted at the body dimensions of the smallest are also in reach for the tallest.

2.2 Functional body dimensions.

Reach envelopes are essential for the design of workplaces. For example, where to put the hand- and foot controls.
In figures 2.2.1 and 2.2.2 the reach envelopes for the 5th percentile men and women are given.

2.2.1 Arm reach.

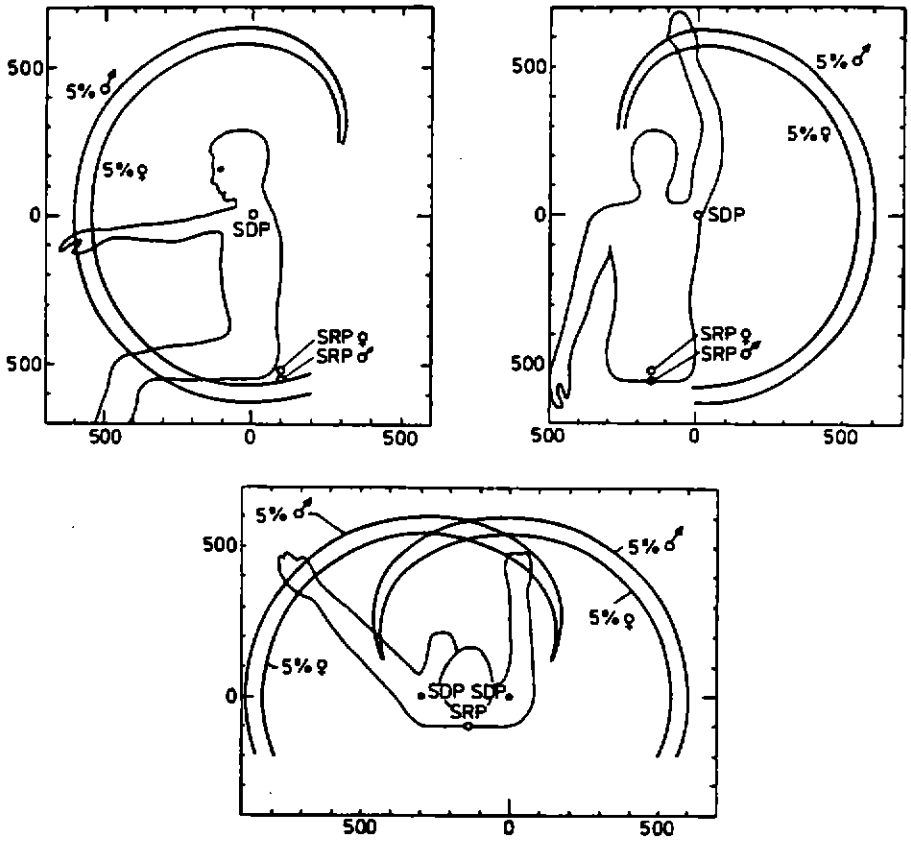

Fig. 2.2.1: Reach envelopes for the arms.

2.2.2 Foot reach.

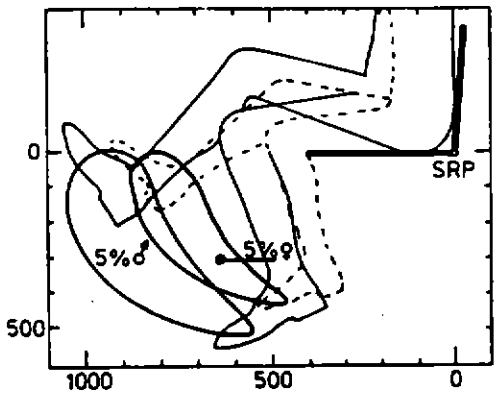

Fig. 2.2.2: Reach envelopes for the foot.

2.2.3 Visual field.

Light signals and displays should be placed within the visual field.

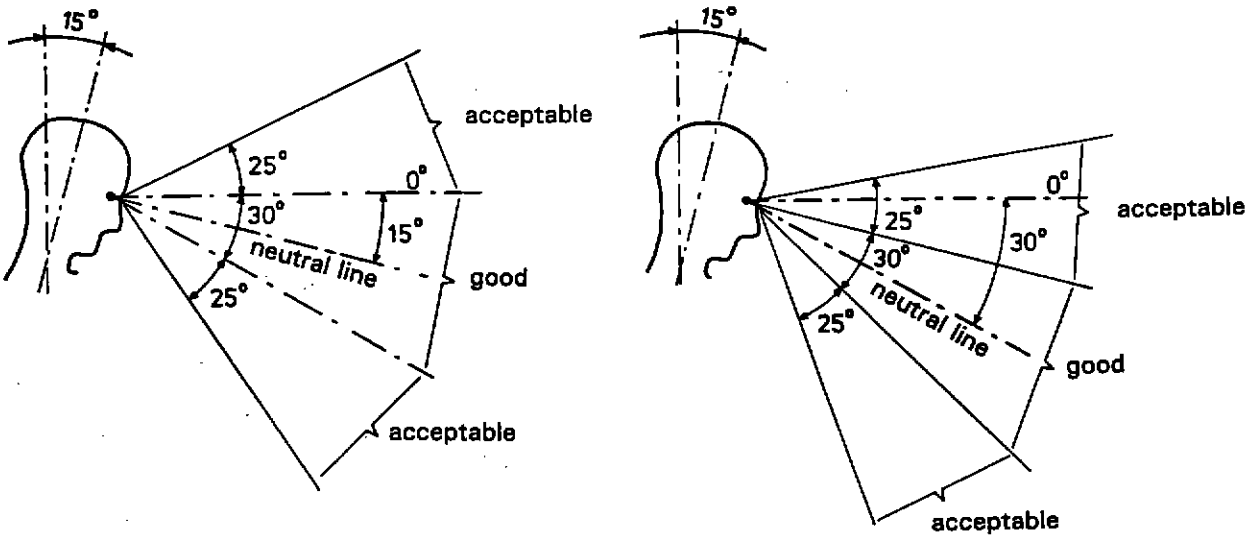

Fig. 2.2.3a: The vertical visual field of view, with head relaxed and eyes straight (left), and head and eyes relaxed (right figure).

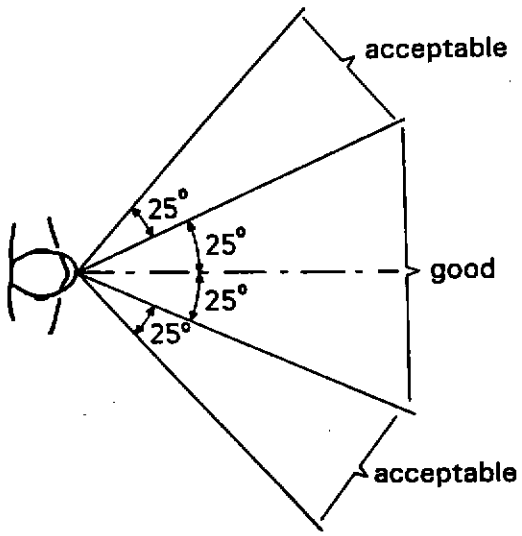

Fig. 2.2.3b: The horizontal field of view, with eye movements ('good' area) and with comfortable head movement ('acceptable' areas).

Chapter 3 - DESIGN RECOMMENDATIONS

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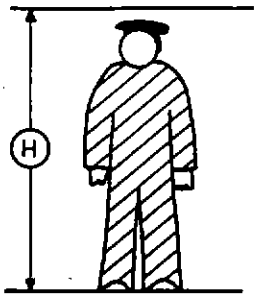
3.1 Overhead clearance.
In all spaces occupied by personnel and in all passageways the minimum clear deckheight H shall be 2050 mm.



3.2 Access Requirements.

3.2.1 General Discussion.

- Access requirements cover the design of catwalks, passageways, hatches and doors. Although treated under WORKSPACE REQUIREMENTS maintenance activities must be considered in the design of all access facilities.

- The need to move tools, equipment and machinery components into and out of shipboard spaces must be considered in the design. In particular such activities affect the size of doors and hatches, the width of passageways and the slope of ladders.

- Damage control activities must also be designed for. For example, the access to all major compartments must permit personnel to enter wearing fireman's clothing and using firefighting equipment, and the exits from all compartments must permit the safe, rapid exit of all personnel.

- The need to move injured personnel by Stoke's litter or stretcher must also be considered in the design, particularly in the areas leading to the sick bay.

- Some access requirements interact with others. For example the angle of an inclined ladder affects the size of the deck hatch at the top of the ladder, and the slope of the ladder is affected by the need to carry equipment up or down. Such interactions have been noted wherever possible: they should be noted in the design process.

3.3 Catwalks.

3.3.1 Discussion.

- Catwalks are recommended only where space or infrequent use preclude normal corridors.

- Catwalks shall be enclosed on both sides, either by a bulkhead and a handrail, or by two handrails.

- An intermediate support rail shall be fitted, midway between the handrail and the floor: The sides between the intermediate rail and the floor shall be enclosed by screening or latticework.

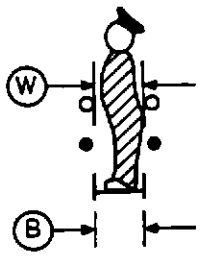
- Toeboards shall be fitted along each side of the catwalk floor.

- The flooring of all catwalks shall be non-skid material. If open mesh material is used, it shall be such as to prevent small tools and other objects from dropping through the floor.

3.3.2 Recommendations.

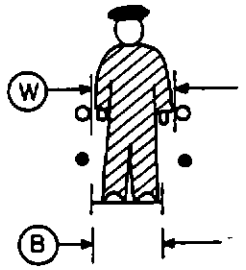
(i) Standing Sideways

Width Between Handrails W	435 mm
Width Between Toeboards B	350 mm



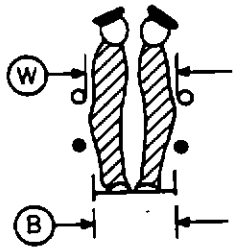
(ii) Walking Normally

Width Between Handrails W	700 mm
Width Between Toeboards B	660 mm



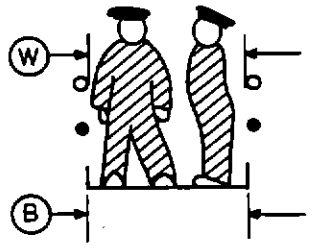
(iii) Passing Sideways

Width Between Handrails W	870 mm
Width Between Toeboards B	700 mm



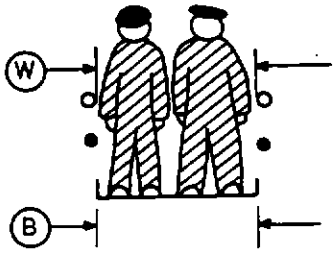
(iv) Passing - 1 Sideways

Width Between Handrails W	1135 mm
Width Between Toeboards B	1050 mm



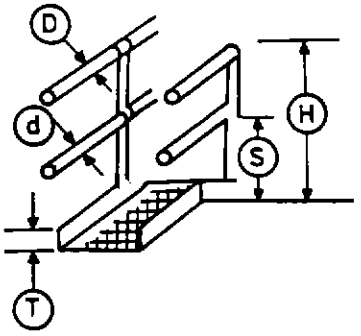
(v) Passing Normally

Width Between Handrails W	1400 mm
Width Between Toeboards B	1350 mm



(vi) Basic Dimensions

Handrail Height H	900 mm
Handrail Diameter D	35 mm
Support Rail Diameter d	35 mm
Support Rail Height S	480 mm
Toeboard Height T	80 mm



3.4 Passageways.

3.4.1 Discussion.

- Passageways must be designed to accommodate the peak traffic load expected.

- In frequently used passageways users should be able to pass abreast; in infrequently used passageways it is acceptable for persons to pass sideways.

- The width of the passageway must accommodate all anticipated uses - for example personnel waiting in line outside the ship's office or sick bay require a wider than normal passageway.

- Where it is necessary to install equipment such as fire-fighting equipment, or drinking fountains in passageways they shall be located in an extension of the passageway (e.g. between supporting ribs) rather than in the passageway itself.

- To make best use of available space passageways should converge at 90°.

- Blind corners should be avoided in the design.

- Doors should not open into passageways: where it is necessary in the design to do so the width of the passageway must be increased.

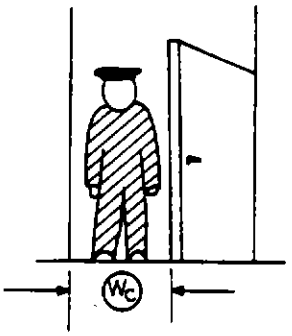
- Passageways should be fitted with easily cleaned non-slip flooring.

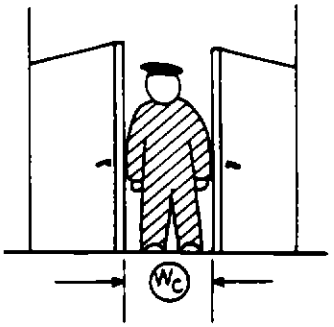
3.4.2 Recommendations I.

(i) Beside Doorways

Width Clear of

Door W_c 700 mm





(ii) Doors

Width Clear of Door W_c

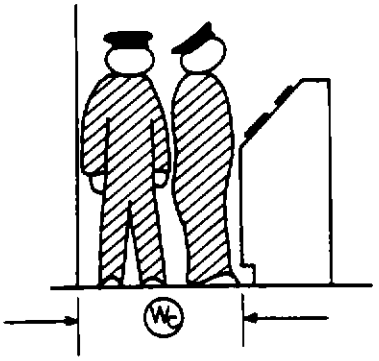
a - Doors in line 700 mm

b - Doors staggered 700 mm

(iii) Behind Console

Width Clear of

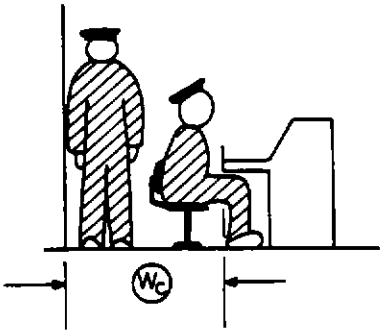
Console W_c 1175 mm



(iv) Behind Desk Console

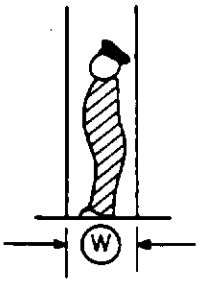
Width Clear of

Console W_c 1250 mm

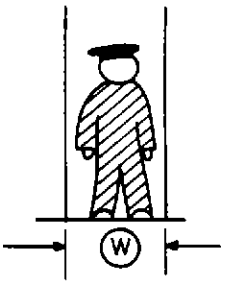


3.4.3 Recommendations II.

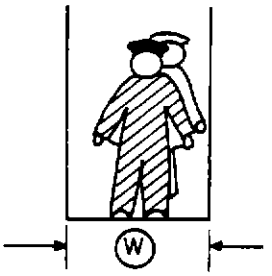
(i) Standing Sideways
Width W 520 mm



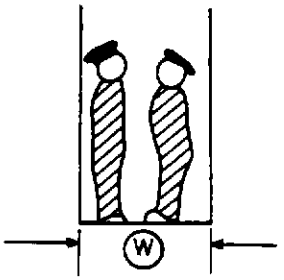
(ii) Walking Normally
Width W 800 mm



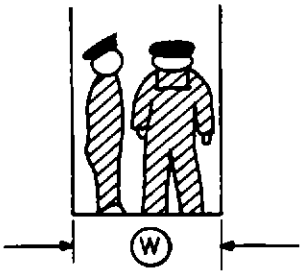
(iii) Carrying Stretcher/Litter
Width W 950 mm
See chapter 10 item (i)
for passage into sickbay



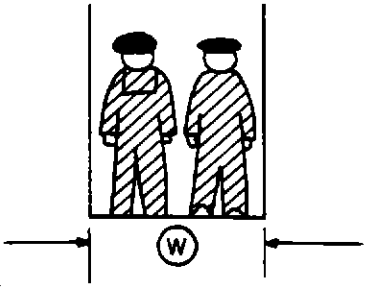
(iv) Passing Sideways
Width W 900 mm



(v) Passing - 1 Sideways
Width W 1200 mm



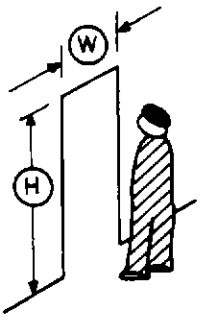
(vi) 2 Person Passageway
Width W 1500 mm



3.4.4 Recommendations - Doorways.

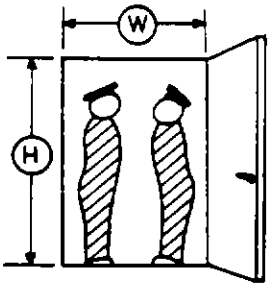
(i) Walk Through - Upright

Width W	800 mm
Height H	2050 mm



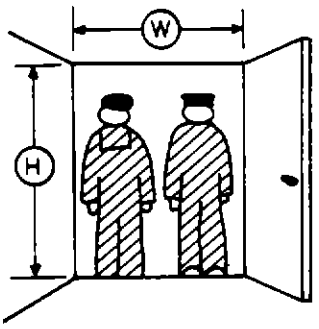
(ii) 2 Persons - Passing Sideways

Width W	900 mm
Height H	2050 mm



(iii) 2 Persons - Passing Normally

Width W	1500 mm
Height H	2050 mm



The width of doorways that are used for transport of sick or wounded personnel on stretchers shall not be less than 900 mm. See item for doorways into sickbay.

3.5 Bulkhead Hatches.

3.5.1 Discussion.

- Hatches should only be employed where environmental conditions require a pressure or water-tight doorway, or where space does not permit a door.

- Reach-through hatches should be employed only to provide access to equipment. They are not intended for the passage of personnel.

- Step-through hatches which require the user to stoop should not be employed where frequent access is required. When employed in a design they should be clearly marked and padded for the safety of users.

- Hatches shall not be used to provide direct access to stairways. Deck openings forming the top of a stairway shall be flush.

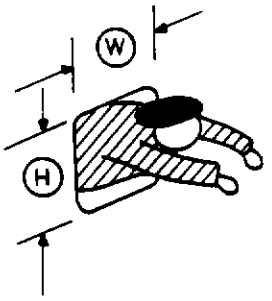
- If users must carry loads through hatches the muscular stress on them is less if they can step erect over a high coaming, rather than stooping through a hatch over a low coaming. Therefore, if the size of the hatch is limited it is better to design a high coaming rather than a low hatchway.

- All hatches which could be used for emergency escape shall be operable with one single motion of the hand or foot. The operating force of any handle or latch on such emergency hatches shall be less than 130 N. The location and functioning of the hatches on emergency exists shall be consistent through-out the ship.

3.5.2 Recommendations

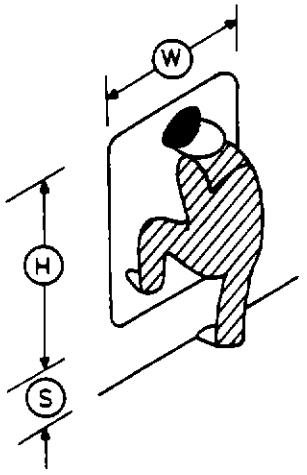
(i) Bulkhead Hatch - Reach Through

Width W	860 mm
Height H	740 mm



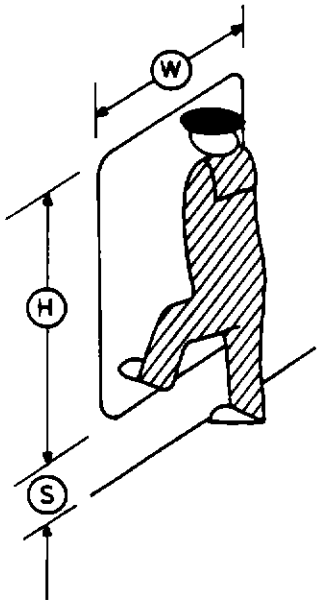
(ii) Bulkhead Hatch - Step Through
- Stooped

Width W	700 mm
Height H	1700 mm
Sill Height S	150 mm



(iii) Bulkhead Hatch - Step Through
- Upright

Width W	700 mm
Height H	1950 mm
Sill Height S	150 mm



3.6 Deck Hatches.

3.6.1 Discussion.

- Manholes and small deck hatches should only be used where very infrequent access is required, for example for maintenance. They should not be used for routine access or for emergency exits.

- A landing of at least 1 square meter shall be provided around all deck hatches served by ladders or stairs.

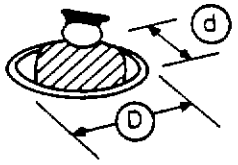
- Safety railings shall be installed around the open sides of all hatches used for routine access to ladders and stairs.

- The length of a deck hatch must be related to the angle of the ladder or stairway it serves. A minimum of 2050 mm overhead clearance must be provided over the treads of the ladder or stairs.

3.6.2 Recommendations.

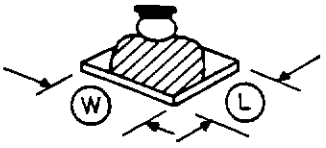
(i) Manhole

Major Diameter D		760 mm
Minor Diameter d		600 mm
	circular	760 mm



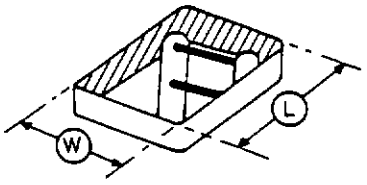
(ii) Deck Hatch

Width W	700 mm
Length L	550 mm



(iii) Deck Hatch - Vertical Ladder

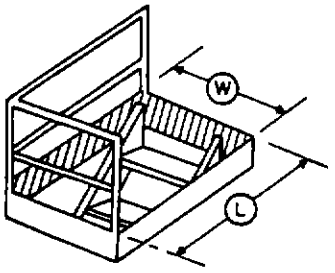
Width W	800 mm
Length L	950 mm



(iv) Deck Hatch - Inclined Ladder

Width W	800 mm
Length L	1050 mm

(L = function of ladder slope)



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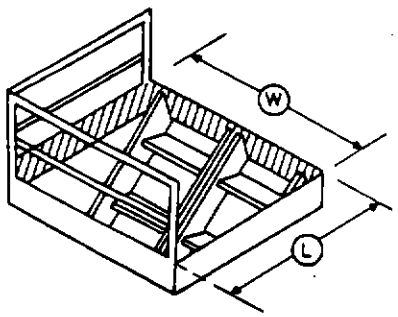


Deck Hatch - 2 Inclined Ladders

Width W	1600 mm
Length L	1050 mm

(L = function of ladder slope)

3.7 Ladders.

3.7.1 Discussion.

- The primary basis for choosing ladders, stair ladders or stairs is usually stated as the angle of the structure, which in turn depends on the available space. The angle of the structure has a major impact on how it can be used, however, so that the function of the structure must be considered, as well as the available space. The steeper the angle the more hazardous it is. Therefore loads cannot be carried up or down dog steps or rung ladders or stair ladders unless they are strapped to personnel.

- Because people learn to use ladders and stairs it is important for reasons of safety that the slope of ladders and stairs be standardized throughout the ship. Thus, for example, on a single ship the angles could be:
  - vertical ladders; 85°
  - inclined ladders; all 70°
  - stairs ; all 50°

  The recommended angles for ladders and stairs are:

	Acceptable	Optimal
- stairs	20° - 50°	25° - 35°
- stair ladders	50° - 75°	50° - 60°
- ladders	75° - 90°	75° - 85°

  Similarly the spacing between rungs or treads should be standardized.

- Dog steps and vertical ladders should be used only for occasional traffic. They are least safe, difficult to climb, difficult to work from, and do not permit the carriage of equipment or tools unless strapped to the user.

- In shipboard spaces vertical ladders and dog steps should be interrupted every 10 or 12 rungs by landings, so that it is impossible for the user to fall far. On ships superstructures where it is impossible to avoid long runs of vertical ladders either a ladder cage should be installed, or the ladder side rails should permit the attachment of a safety harness on a running link.

- Stair ladders encourage users to face outwords (i.e. away from the ladder) when descending them, which is more hazardous then descending a ladder at the same angle, facing inwards. Stair ladders also encourage the dangerous practice of sliding the hands and feet down the handrails. For these reasons steep stair ladders are not recommended.

- In engine rooms, machinery spaces and other areas where equipment and tools must be regularly carried up and down stairs, the angle of the stairs should be no more than 50° from the horizontal.

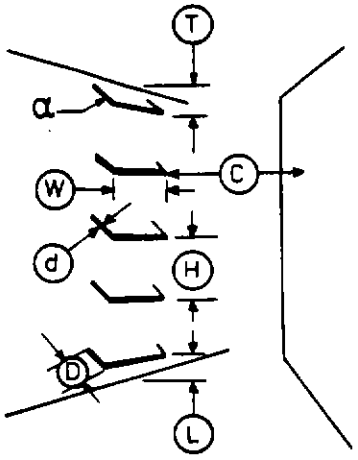
- There shall be no change in direction of a ladder or stair without an intermediate landing.

- The treads of all stair ladders and stairs should be covered in non-slip material, and the forward of edge of the tread should be rounded.

3.7.2 Recommendations.
Except for clearances, these data are not based on the data given in Chapter 2.

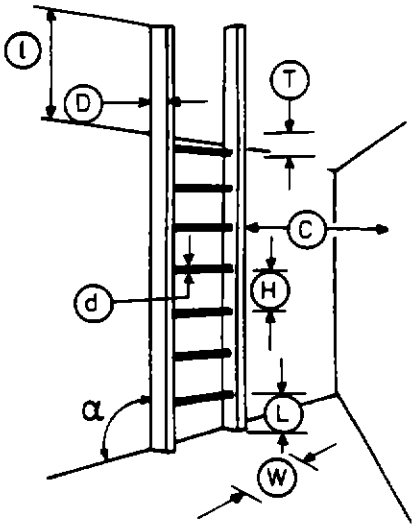
(i) Bulkhead Mounted Rungs (Dog Steps)

Rung to Opposite Bulkhead C	965 mm
Rung Spacing H	300 mm
Top Rung to Deckhead T	300 mm
Bottom Rung to Deck L	300 mm
Rung Width W	400 mm
Rung Depth D	220 mm
Rung Diameter d	35 mm
Rung Angle α	90°



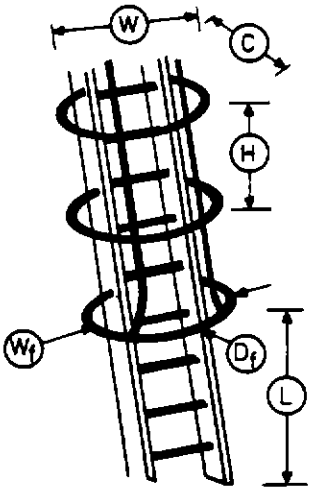
(ii) Rung - Ladder

Ladder Angle α	85°
Rung Spacing H	300 mm
Top Rung to Deckhead T	300 mm
Bottom Rung to Deck L	300 mm
Width W	450 mm
Rung to Bulkhead (Min) D	200 mm
Rung Diameter d	35 mm
Rung to opposite Bulkhead C	965 mm
Overhanging-support l	1000 mm



(iii) Ladder Cage

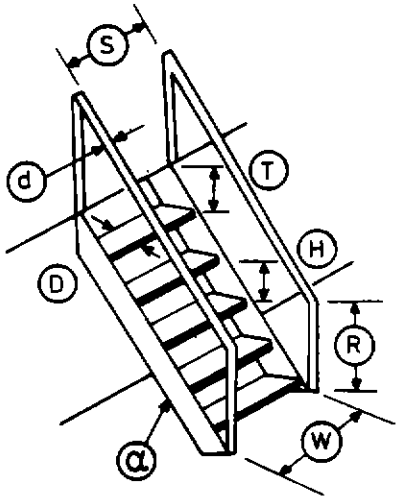
Cage Rib Spacing H	460 mm
Rib Width W	750 mm
Rib Depth C	770 mm
Flare at Bottom W_f	850 mm
Flare at Bottom D_f	810 mm
Bottom Rib to Deck L	2050 mm



3.7.3 Stair ladders.
Except for clearances, these data are not based on the data given in Chapter 2.

Single Ladder

Ladder Angle α	50°	75°
Tread Spacing (Rise) H	230 mm	250 mm
Top Tread to Deckhead T	230 mm	250 mm
Tread Depth D	>180 mm	>190 mm
Tread Width W	560 mm	560 mm
Handrail Height R	900 mm	900 mm
Handrail Spacing S	560 mm	560 mm
Handrail Diameter d	35 mm	35 mm



3.8 Stowage.

3.8.1 Discussion.

- All items to be stowed should be capable of being stowed or unstowed by the smallest and largest likely operators.

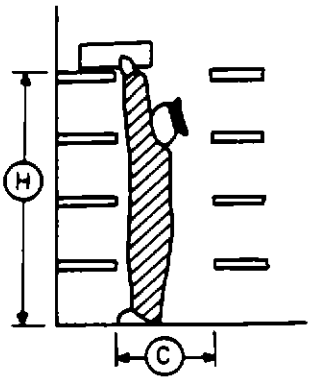
- All stowed items should be secured or restrained against the effects of ship motion.

- The contents of all stowage facilities should be clearly marked on the exterior of the stowage facility.

- Where the items to be stowed weigh more than can easily be handled by 1 operator (20 kg), the stowage should be designed to permit multiple operators or the use of materials handling equipment (hoists etc.).

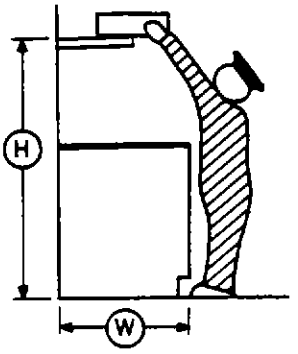
3.8.2 Recommendations.

(i) Max. height H, light objects (10 kg)
standing close to shelf 1950 mm
Clearance to bulkhead or
opposing shelves C 650 mm*
* = + depth of the material

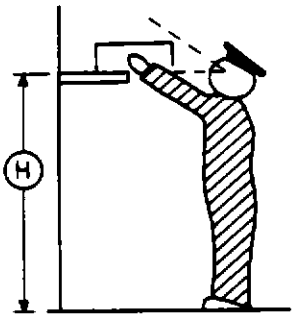


(ii) Max. height H, light objects (10 kg)
Reaching over bench

W 350 mm	H 1900 mm
W 600 mm	H 1800 mm
W 800 mm	H 1700 mm

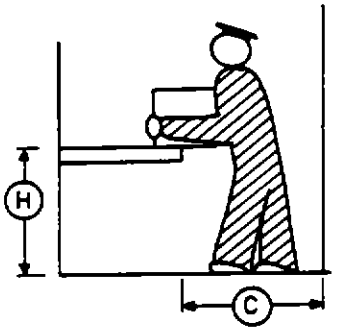


(iii) Max. height H
to see into shelf 1550 mm



(iv) Max. height H, for objects Wt,
Min. width for aisle, C

Wt 16 kg	H 1500 mm	C 600 mm
Wt 20 kg	H 1200 mm	C 600 mm
Wt 25 kg	H 900 mm	C 900 mm



Chapter 4 - WORKPLACES

Content

4.1 General Considerations.

4.1.1 Discussion.

- In this section principles and data are presented for standing, sit/stand and sitting workplaces.

- The selection of the working posture will be a function of the task to be performed, among others the duration and frequency of use of the equipment.
  Kneeling and squatting should only be required for infrequent operations such as maintenance.
  Standing is required for occasional operations which require mobility, or for occasional maintenance.
  Sit/Stand postures should be employed for routine operations where the operator is required to be occasionally mobile. Refer to Fig. 1.2.2 for the selection of the type of workplace.

- The effectiveness with which personnel can perform such tasks depends upon:
  * all displays being easy to see and read, with minimum parallax error,
  * all controls being easy to reach and operate.

- Although in this guideline data are given only for physical dimensions of panels, consoles, etc., in paragraph 4.2 the general approach to workspace design is outlined. The reader may refer ANEP 20 and ANEP 27 for details.

4.2 Procedures for designing workplaces.

4.2.1 Required analyses.

It should be determined which information has to be displayed, which controls and which communication equipment are required at a specific workplace (c.f. ANEP 20).

This should be done taking into account the following aspects:

- Purpose of the device.
- Operational mode in which the device will be applied.
- Functional chains, of which the device is an element.
- Functional links to other equipment.
- Type and place of installation (e.g. CIC).
- Influencing factors relating to the place of installation (e.g. climate, lighting, EMC).

The following analysis have to be carried out:
- Function analysis.
- Function Allocation to man or machine.
- Task analysis.
- Analysis of skills of the expected operator.

4.2.2 Required data derived from the analyses.
- Sequence of operation.
- Type and amount of information to be displayed.
- Work elements of controlling tasks.
- Type and amount of controls.
- Communication requirements.
- Type and amount of communication equipment.
- Relative importance of displays and controls and expected frequency of use.
- Writing area and stowage for handbooks.
- Maintenance requirements.
- Environmental factors.
- Operational, maintenance, and training requirements.

4.2.3 Determination of size and arrangements of spaces for displays and controls, according to the data given in 4.4.

4.2.4 Console and desk design.
- Some examples of console and desk design are given in para 4.4.

4.3 Space and height requirements.

4.3.1 Working height.

The type of task to be performed determines the height of the worksurface. The relationship between task demands and work height is given below for both sitting and standing work places.
The workheight given below is the height at which the task must be performed.
The following distinctions are made based on three types of task requirements.

Task demands: average requirements for visual perception and motor skills. For example; Administrative work.
Work height: 50 mm above elbow height.

Task demands: Low requirements for visual acquisition, high demands for freedom of arms. For example; Preparation work e.g. kitchen.
Work height: 50 mm below elbow height.

Task demands: high requirements for freedom of arms and high force excitation. For example; Motor Repair.
Work height: 100-400 mm below elbow height (depending on the task).

4.3.2 Leg room.

For all types of workplaces it is important that there is sufficient leg room. For three types of workplaces the required free room for legs and feet is given.
In Fig. 4.3.2 the leg room for sitting work places is defined. A distinction is made between tasks of long sitting duration and those that are of short duration. Within the dashed lines apparatus can be built in if necessary. The lower line is indicated with 'foot support surface'. This means that for higher workplaces (sit/stand) on that level foot support must be provided.

The minimal required breadth for legs under a desk must be 600 mm; for work heights > 850 mm the required leg breadth must be > 800 mm.
For a good posture the thickness of the desk should be as thin as possible. For keyboard and writing tasks the thickness may never be more than 35 mm.

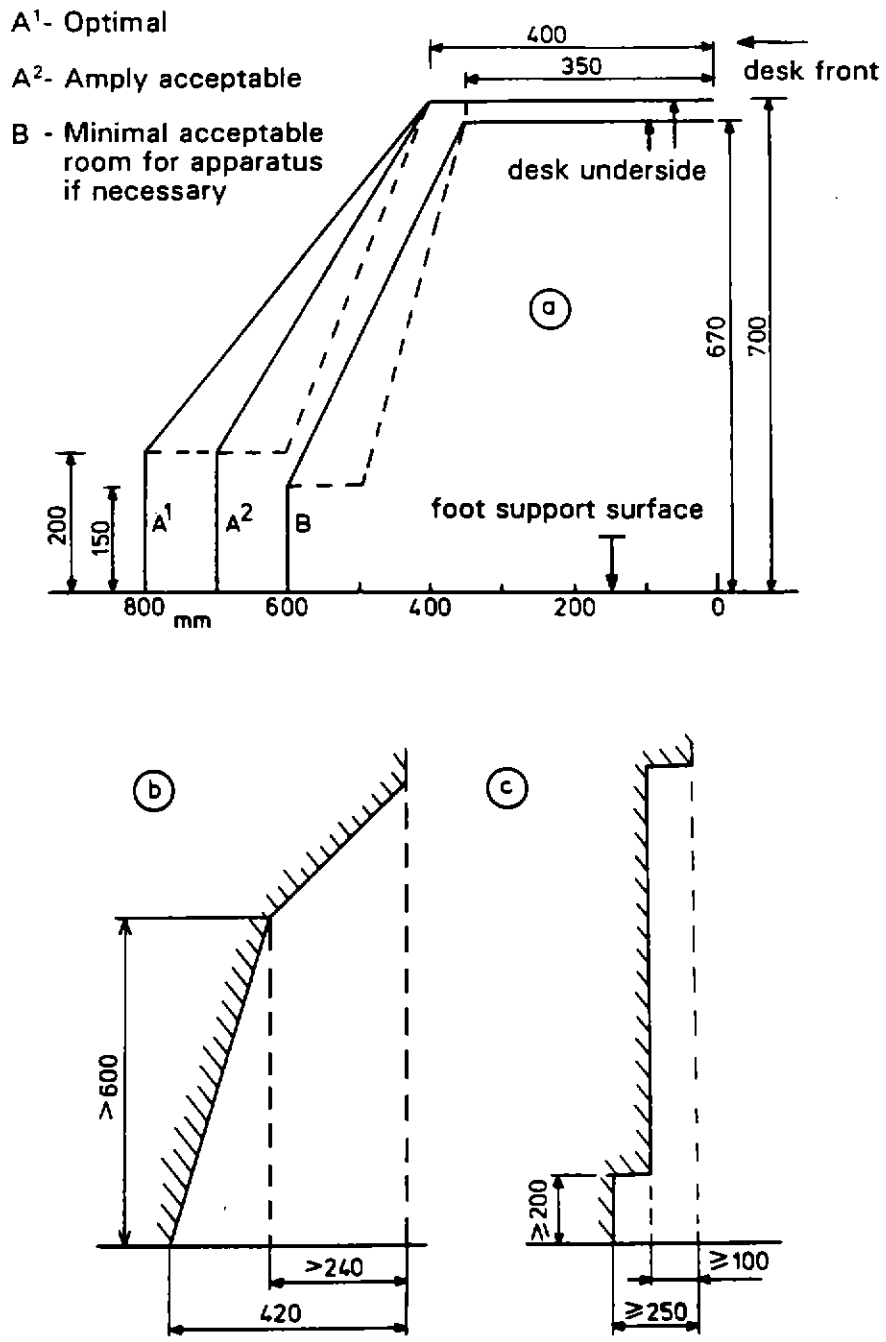
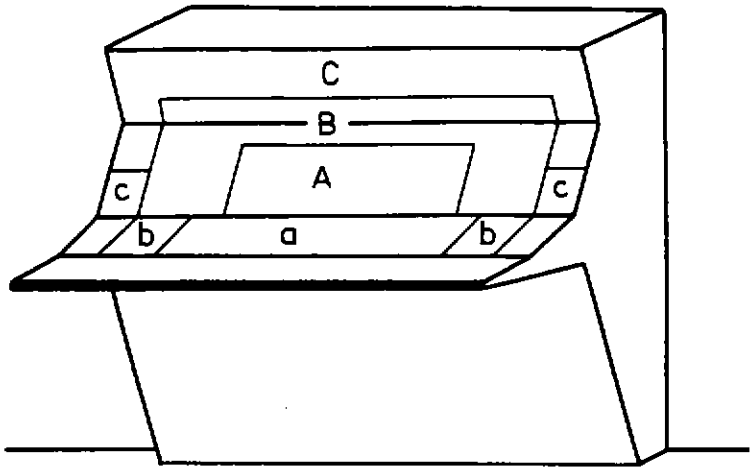


Fig. 4.3.2: Required leg room for a sit workplace (a), a sit/stand workplace with stand support (b) and a stand workplace (c).

4.4 Panel design.

4.4.1 Control and display areas.



A	displays	important and frequently used displays and
a	controls	controls in this area

B	displays	infrequently used displays and controls
b	controls	in this area

C	displays	less infrequently used displays and controls
c	controls	in this area

Fig. 4.4.1a: Panel size and surface configuration with critical and less critical areas for displays and controls.

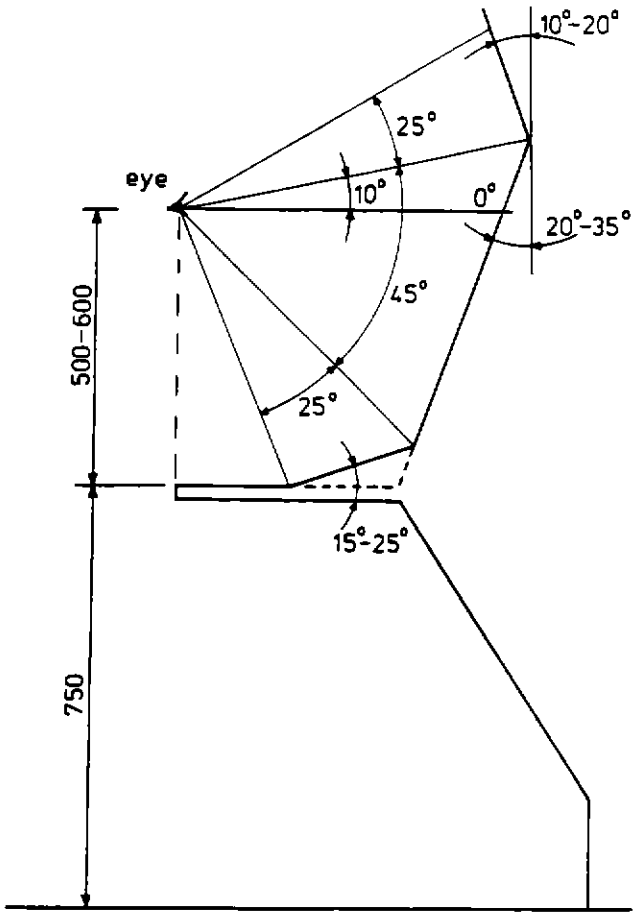
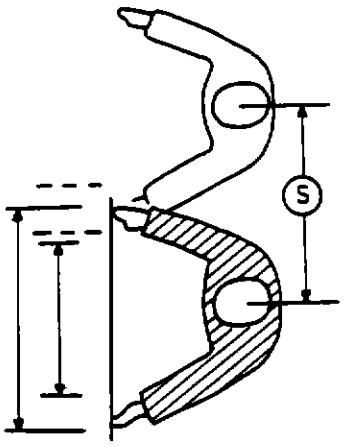


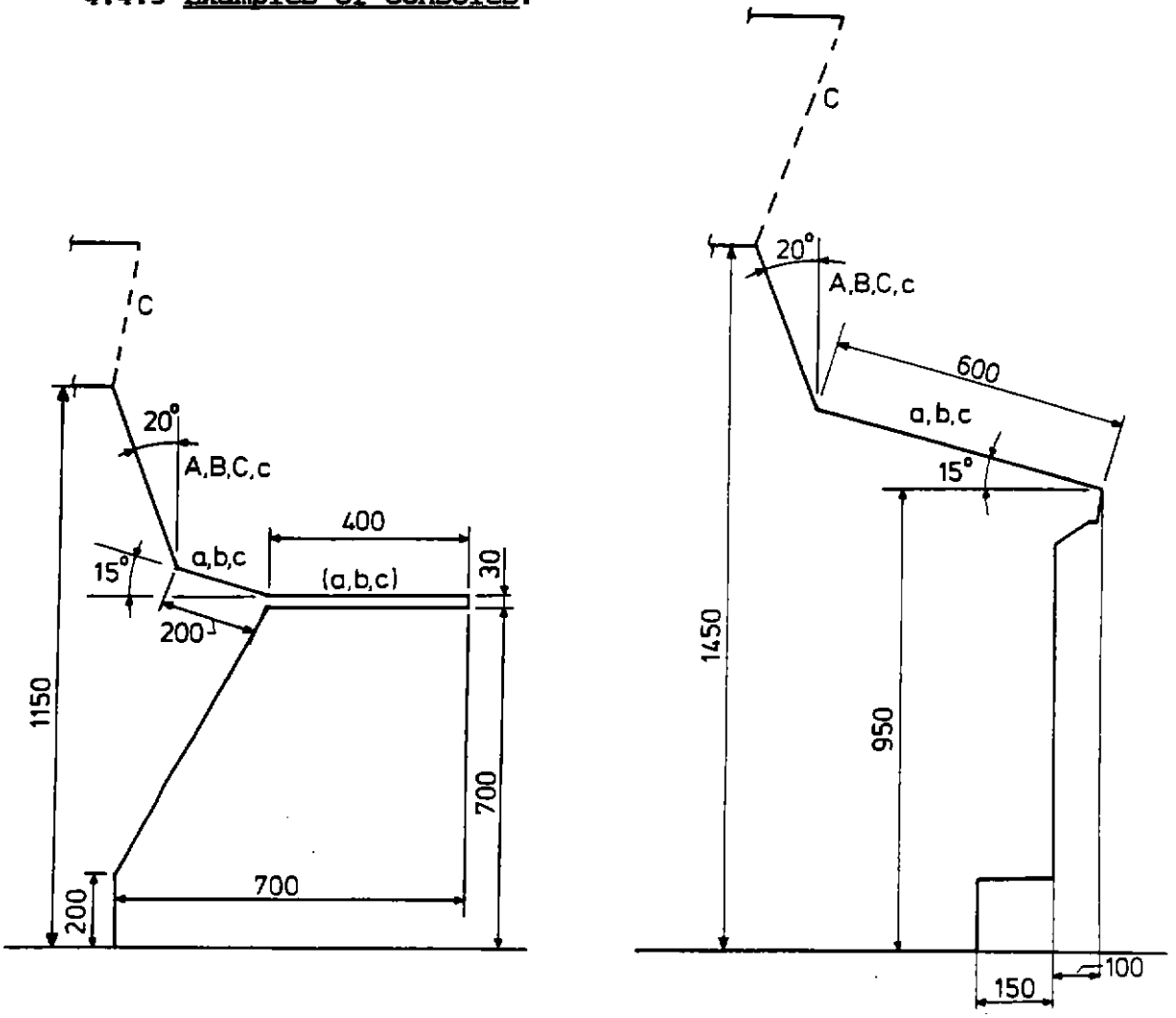
Fig. 4.4.1b: Panel design based upon optimal viewing angles (see para. 2.2.3). For reach envelopes see para. 2.2.1.

4.4.2 Space between operators.

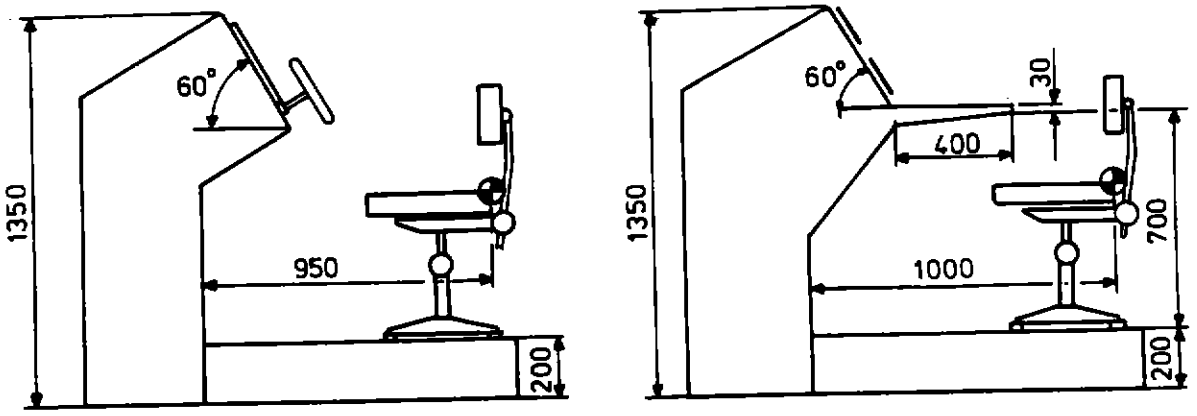
Min. Spacing Adjacent Operators S	650 mm
Width of Area for Shared Controls	320 mm
Max. Control Area Width	1500 mm
Pref.Control Area Width	700 mm



4.4.3 Examples of consoles.



Figures 4.4.3a: Examples of the dimensions and layout of a console for sitting (left) and a console for standing operation (right).
The characters (A, c, etc.) refer to the control and display areas (see figure 4.4.1.a)



Figures 4.4.3b: Examples of the dimensions of a sit-stand console. The chair is placed on a platform. The height of the console depends on the required line of sight.
Left: Conning and navigation console
Right: Console officer on duty

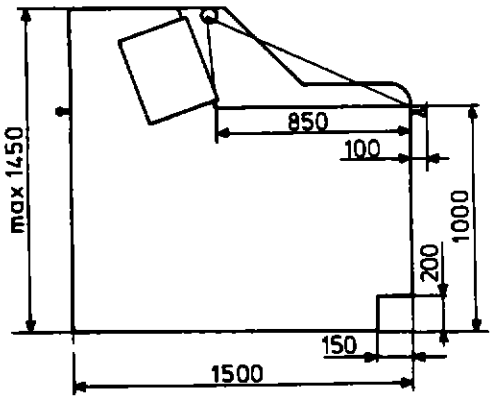


Figure 4.4.3c: Example of the dimensions of a chart table

Chapter 5 - SEATING

Content Page no.

5.1 Discussion.

- The advantages of having operators sit, rather than stand are:
  - the operator is less fatigued when sitting,
  - it provides greater stability and better equilibrium
  - the operator can use foot controls
  - the range of eye heights to be designed for is half the range of standing operators.

- Wherever the operator is seated for more than an hour at a time, or for more than 20 percent of the time of each shift, the seat should be padded for comfort. Uncushioned seats should only be used for short-term or for intermittent seating.

- Cushioning should be firm, rather than soft, and ventilated or breathable.

- By the selection of chairs and the position relative to the work surface people should be given as much freedom as possible to change posture. Larger backrests are therefore preferred to small backrests, because they provide more opportunity for changing positions.
  Similarly armrests should be provided because they enable the operator to "shift his weight".

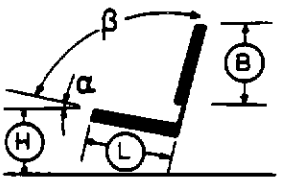
- Care should be taken in designing armrests which do not interfere with console or desk writing surfaces.

- The curvature of the backrest of a seat is critical to comfort; adequate lumber support should be provided.

5.2 Recommendations.

Settee-type seating (for messes, longrooms, recreation)

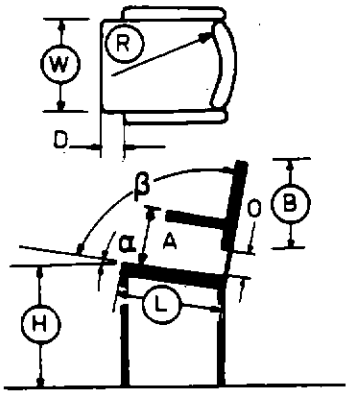
Seat Width/person W	550 mm
Seat Height H	370 mm
Seat Length L	480 mm
Seat-back Height B	500 mm
Seat Angle α	6° - 10°
Seat-back Angle ß	100°-110°



5-3

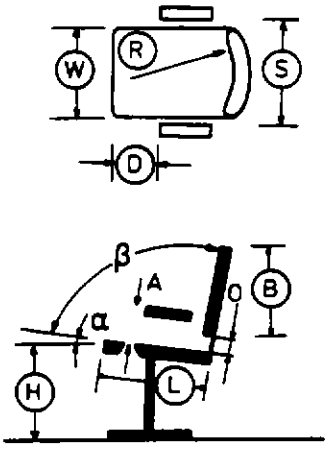
Conventional Chair (for study, eating, etc.)

Seat Width W	470±20 mm
Seat Height H	450 mm
Seat Length L	430±20 mm
Armrest Height A	240±10 mm
Armrest to SF D	150 mm
Seat-back Height B	300 mm
Seat-back Angle β	95°
Back-radius R	400 mm
Space O	120 mm
Seat Angle α	0° - 3°



Work Chair (for desk height: 720-750 mm)

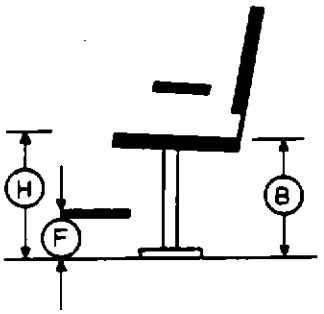
Seat Width W	420±20 mm
Seat Height H (if fixed)	450 mm
Seat Height H (pref.adjust.)	460±40 mm
Seat Length L	400±20 mm
Armrest Height A	240±10 mm
Armrest to SF D	150 mm
Width between Arms S	500 mm
Seat-back Height B	300±50 mm
Seat-back Angle β	85°- 110°
Seat Angle α	0° - 5°
Back-radius Top R	400 mm
Space O	120 mm



Pedastel Chair (for desk height: 750 + X mm)

Seat height H (if fixed)	X+450 mm
Seat Height H (pref.adjust.)	X+460±40 mm
Footrest Height F	X mm

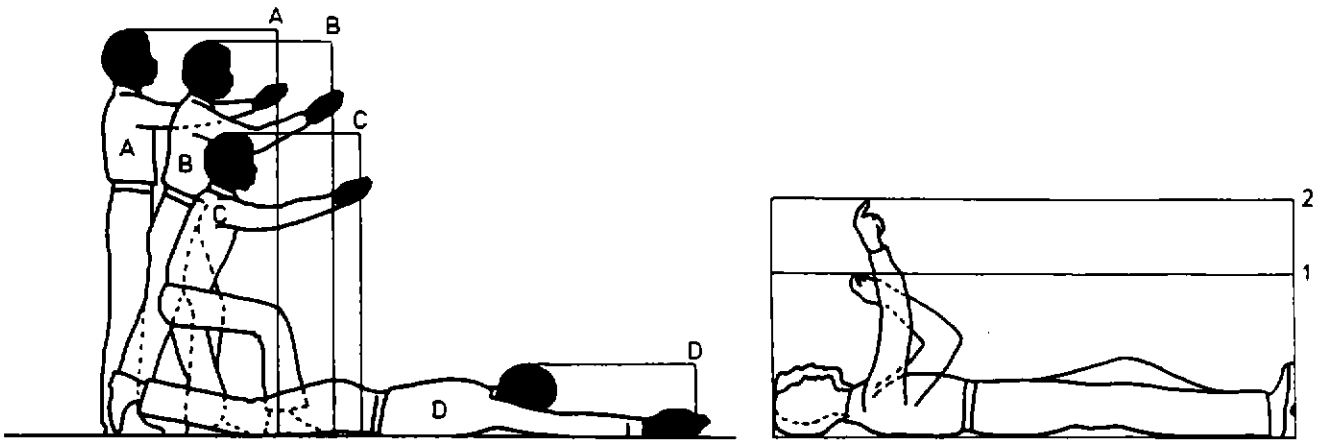
Other dimensions as for work-chair (above).



Chapter 6 - MAINTENANCE WORKSPACE

Content Page no.

6.1 Required body space.



Working position:	Minimum dimensions Vertical (mm)	Horizontal (mm)
A Standing	2100	750
B Standing, legs braced	2100	1000
idem, for excerting force		
C Kneeling	1200	1200
D Prone	680	2400
Working position:		
1 Light mechanical activity	680	2100
2 More heavy mechanical activity with 200 mm long tools	880	2100

Fig. 6.1a: Minimal Working Space (mm) for maintenance.

When (apparatus) drawer is pulled out the minimal required body space is 450 mm. Drawers and doors should be locked.

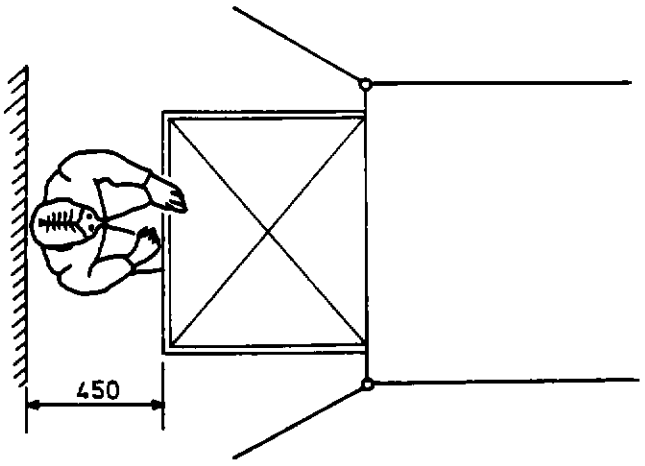
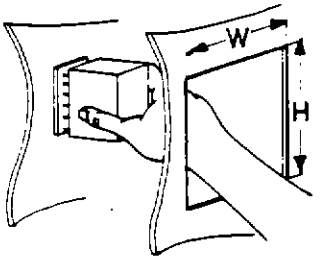


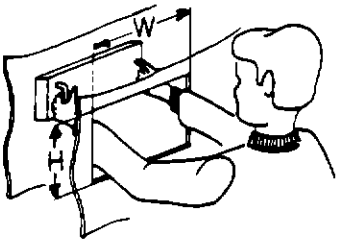
Fig. 6.1b: Required working space behind drawers (mm).

6.2 Access for removal/replacement.

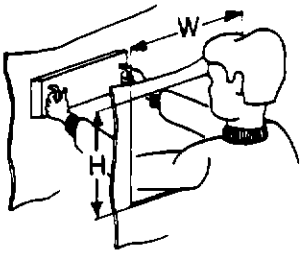
One hand Crasping Object
Width W object width + 50 mm
Height H object height + 50 mm (min. 125)



Two hand - Hand & wrists extended through opening
Width W object width + 120 mm (min. 400)
Height H object height + 50 mm (min. 125)

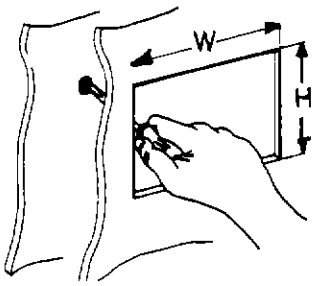


Two hand - Arms extended through opening
Width W object width + 120 mm (min. 500)
Height H object height + 50 mm (min. 125)

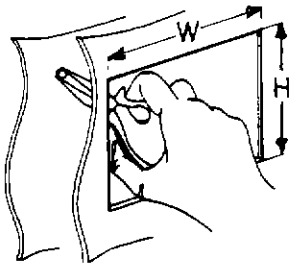


6.3 Access for tools

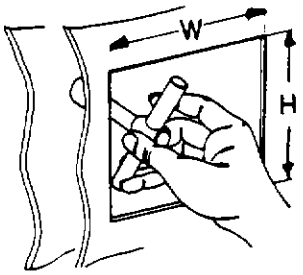
Normal Screwdriver
Width W 115 mm
Height H 115 mm



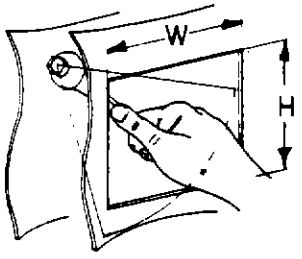
Pliers
Width W 130 mm
Height H 130 mm



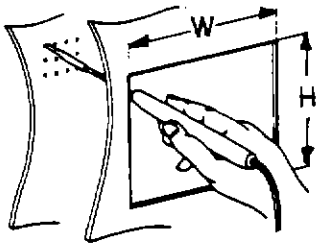
T-Handle Wrench
Width W 135 mm
Height H 135 mm



Open-End Wrench
Width W 270 mm
Height H 200 mm



Test Probe - Small soldering iron
Width W 100 mm
Height H 100 mm
or 100 mm dia



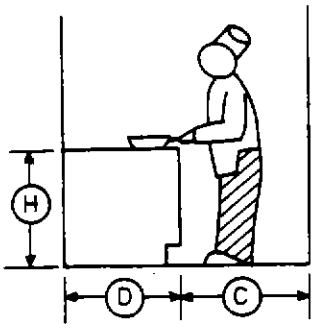
Chapter 7 - GALLEYS

Content Page no.

7.1 Dimensions.

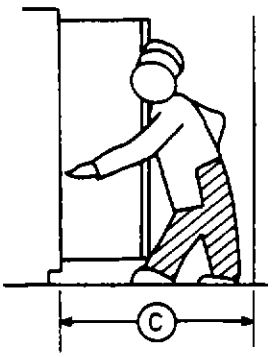
Preparation Table

Workspace Depth C	1050 mm
Table Depth D	650 mm
Table Height H	950 mm



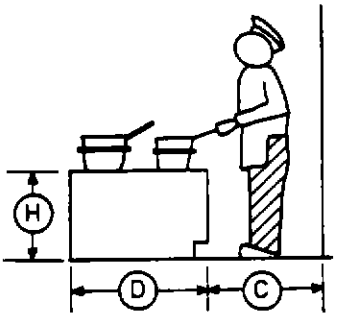
Refrigerator or Galley Cupboard

Workspace Depth C clear of front of unit	1050 mm



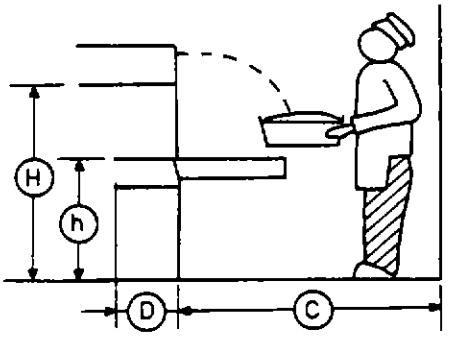
Range Top

Workspace Depth C	1050 mm
Range Depth D	650 mm
Range height H	850 mm



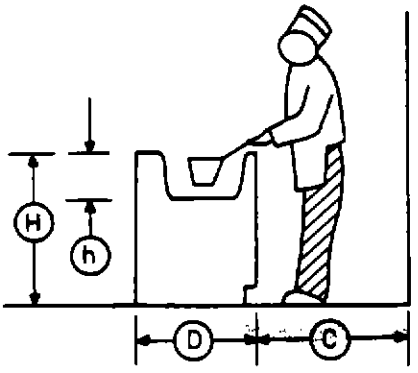
Ovens

Workspace Depth C	1200 mm
Range Depth D	650 mm
Max. Loading Height H	1250 mm
Min. Loading Height h	850 mm



Pot Sink

Workspace Depth C	1050 mm
Sink Front-Back Depth D	600 mm
Work Top Height H	950 mm
Sink Depth h	<400 mm

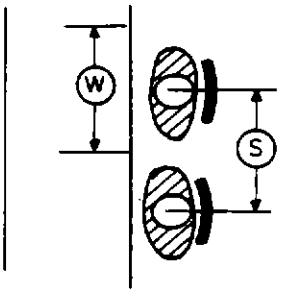


Chapter 8 - ACCOMMODATION TABLES

8.1 Dimensions.

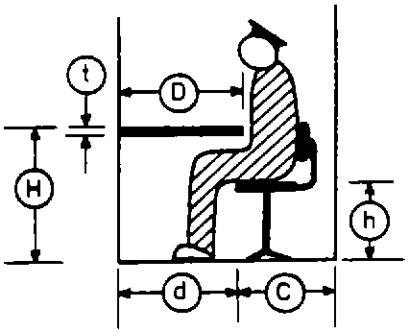
Mess Table

Preferred Table Width/Person W	650 mm
Min. ctr-ctr Spacing S/Person	650 mm



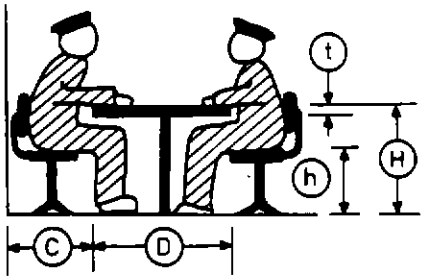
Mess Table - 1-sided

Seatspace Depth C	700 mm
Table Depth D and legspace d	600 mm
Table Top Thickness t	30 mm
Table Top Height H	720 mm
Seat Height h	450 mm



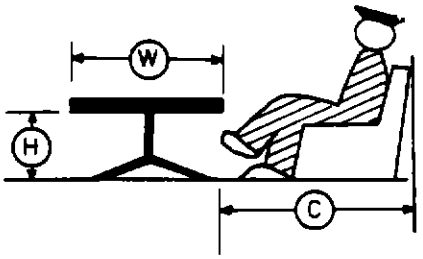
Mess Table - 2-sided

Seatspace Depth C	700 mm
Seatspace Depth including room to get up from the table	900 mm
Table Depth D	750 mm
Table Top Thickness t	30 mm
Table Top Height H	720 mm
Seat Height h	450 mm



Lounge Table

Seatspace Depth C	1200 mm
Width W	600 mm
Height H	550 mm



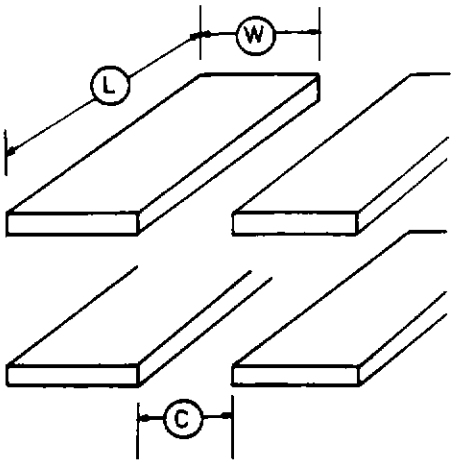
Chapter 9 - BERTHS

Content Page no.

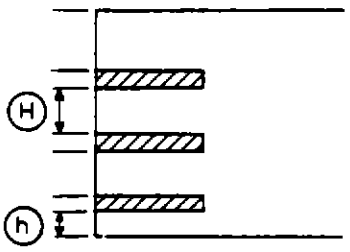
9.1 Dimensions.

See paragraph 10 item (iii) for details of Sick Bay berths

Min. Length L	2100 mm
Min. Width W	750 mm
Min. Spacing between opposing berths C	800 mm



Min. Vertical Separation between bunks, or bunks & deckhead H	700 mm
Min. Clearance between bunks & deck h	250 mm

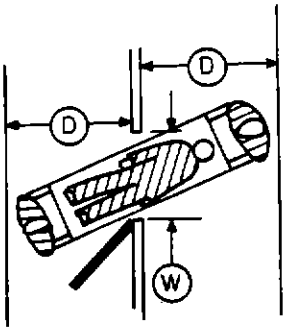


Chapter 10 - SICK BAY

10.1 Dimensions.

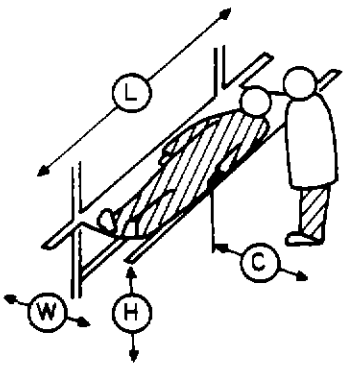
(i) Entrance Door for Stretchers

Min. Clear Passageway Depth either side of door D	1250 mm
Min. Door Width W	1250 mm
Double Door	1500 mm



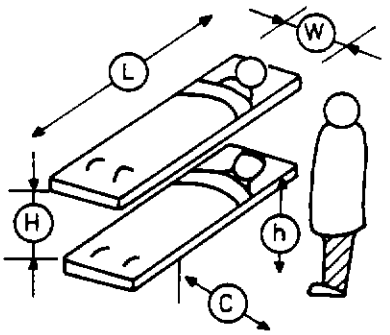
(ii) Space for Patients on Stretchers

Length L	2300 mm
Width W	600 mm
Height H	750 mm
Width Workspace around Stretcher C	650 mm



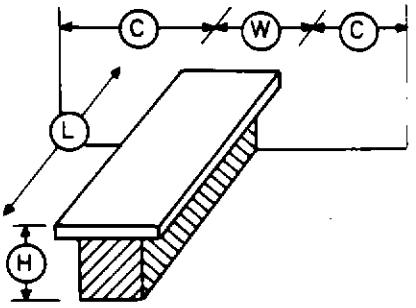
(iii) Sick Bay Berths

Length L	2100 mm
Width W	700 mm
Min.Vertical Spacing H	800 mm
Width Workspace around Berths C	650 mm
Min. Berth Height h	750 mm



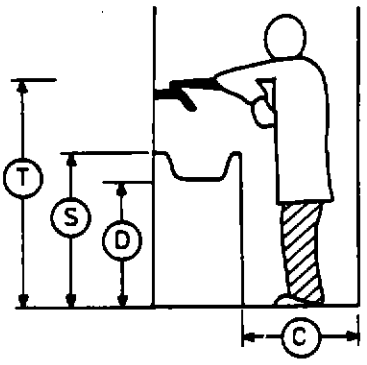
(iv) Examination and Operating Table

Table Length L	2100 mm
Table Width W	600 mm
Table Height H; or adjust	750 mm
Width Workspace around Table C	800 mm



(vi) Sick Bay Sink, Elbow Operated Tap

Workspace Depth C	1050 mm
Height Tap Handle T	1250 mm
Height Sink S	950 mm
Sink Depth D	750 mm



Note: workspace depth, usually a clear area

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