ACCENT ON ACCESS-THE "INS" AND "OUTS"

OF MACHINERY SPACES

JOHN R. WRIGHT

REPRINTED FROM
JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS, INC.
VOLUME 65, No. 2, MAY, 1953.

Beresford, Printer
605 F Street. N. W.,
Washington. D. C.

ACCENT ON ACCESS THE "INS" AND "OUTS" OF MACHINERY SPACES

JOHN R. WRIGHT

THE AUTHOR

A native of Washington, D. C., graduated from the U. S Naval Academy in 1940. He served in the Navy in engineering billets and at the Post Graduate School at Annapolis until 1948. Since then he has been employed in the Machinery Design Division of the Bureau of Ships in a civilian capacity.

INTRODUCTION

Machinery arrangement design is a complex art which has in most respects kept pace with the technological improvements reflected in the modern warship. There are, however, certain details of machinery arrangement practice for which no sound design principles appear to exist. A typical example would be the provisions of machinery space access. While this may well be regarded as a detail, it is nonetheless a vitally important feature of warship design. Perhaps no other single element of combatant vessel design directly involves such conflicting considerations of personnel safety and water-tight integrity as the provisions for machinery space access. It therefore seems reasonable to presume that some useful purpose might be served by attempting to analyze specific requirements, and establish acceptable design criteria with respect to machinery space access in general.

The water-tight integrity of machinery spaces has always been regarded as a matter of vital importance in warship construction. Thus, the piercing of transverse bulkheads by doors is taboo, and machinery space access is strictly an "up and over" proposition. Unfortunately, it is at this fundamental level that all semblance of access standardization disappears; as is evidenced by the great variety of access arrangements provided in existing combatant vessels. Design is admittedly a process that thrives on compromise, and thus minor differences are to be expected. However, the basic principles of water-tight integrity apply equally to all major combatant vessels, regardless of type. A suspicion therefore arises that so far as the machinery arrangement designer is concerned the degree of importance accorded water-tight integrity decreases in proportion as the design project increases in complexity. Accordingly, as a design progresses, a serious compromise of fundamental space-integrity may be incurred (perhaps unintentionally) in favor of, say, providing a more conveniently located pump.

If we wish to prevent such dangerous expedients as may well jeopardize an entire main machinery space in battle, and at the same time, avoid the recurring problem of access now common at some stage in all design developments, then we need only to establish acceptable standards of access and adhere to them to the fullest practicable extent; specifically justifying any and all deviations. These standards should include considerations of type, size, number, and location of major machinery space accesses.

GENERAL

A complete absence of access openings is the ideal solution to threats against water-tight integrity. While this is an unrealistic solution it does suggest two very practical rules, namely —minimize the number of access openings, and minimize the interval they are open. The problem then arising concerns a determination of the various necessities for access. During- the recent war access openings and associated trunks were used for personnel traffic, material traffic (machinery components, repair equipment damage control equipment, etc.), gravity drainage routes for de-watering upper spaces (flooded from sea or by fire hoses) via the more readily pumped machinery space bilges, suction wells for portable submersible pumps (used to de-water flooded machinery spaces), and as an alternate ventilation supply route when use of normal air Inlets also introduced smoke.

While the foregoing is indicative of the vast range of uses to which access routes are adapted, it also serves to emphasize that personnel traffic is not only more or less involved in all other uses, but represents the only continuous (as opposed to highly occasional) use. Except for personnel traffic all uses of access are largely incidental to the existence of the access (and could otherwise be provided for, as by semi-fixed bolted plates) and do not therefore constitute the reason the access is provided. It is clear then that the primary need for access is personnel traffic.

Unfortunately little information as to the manner in which access provisions served this primary purpose during the last war is available. In this respect a means of access is like a parachute— when it works it merits no comment; when it fails no one survives to comment. However, in the following analysis the controlling consideration will be the suitability of access provisions with respect to their primary use—personnel traffic.

TYPE

Experience gained in the recent war emphasized the desirability of the following features with respect to access openings:

1. No openings into trunks are justified from other than the machinery space served and the upper exit compartment.
2. Access routes should be trunked from the machinery space overhead to above the waterline.
3. Upper exits should be coamed out even though above the waterline.

ACCESS

All access openings and routes should be primarily designed for personnel traffic and for that reason should provide for quick-acting closures, since such traffic is not only fairly continuous but frequently hurried. It is obvious that slow-operating access openings only encourage their being left open or partially secured; and neither condition can be tolerated in the face of the increased threat of surprise attack. Moreover, if complete absence of openings be recognized as the ideal then minimum open interval most nearly approaches that ideal. And lastly, the machinery spaces are below the waterline, and flooding from the sea represents the fastest-traveling damage potential short of actual explosion. The full import of these considerations is simply that where large hatches are involved they should in all cases be fitted with quick-acting scuttles.

One access route per space should incorporate the maximum number of features adapting the access to other secondary uses, in so far as such features don't compromise the requirements for personnel traffic. Since such uses are highly occasional they may incorporate slow-operating features, even including removable bolted plates.

Broadly speaking there are only two fundamental types of access— normal and emergency.

Normal access is designed for continuous use, and the most rapid and convenient use compatible with the all-important objective of maximum water-tight integrity. It therefore involves inclined ladders and is unenclosed within the space it serves; but is trunked outside the machinery space to above the waterline so as not flood to or from intermediate deck level compartments.

Emergency access is conceived primarily as an alternate escape and otherwise infrequently used access. Perhaps the prime necessity for alternate escape routes consists in the possibility of an overhead barrier of steam, gas, or smoke; and accordingly this type of access should be trunked to the lower machinery level. Doors in all trunks should open inward, as there have been instances where doors opening outward could not be opened in emergencies due to obstructing debris or the rising head of flood water within a space.

To minimize weight and space penalties all trunks should be vertical. A vertical trunk offers many advantages with respect to secondary uses of access, while a slanted trunk does not conversely benefit personnel traffic. For example, a straight-drop trunk provides an excellent means for raising and lowering cumbersome equipment by improvised hoists. It is similarly best adapted to portable ventilation and air line rigs (as used in navy yards or in battle emergencies), requiring less material, and being easier to so rig. During the recent war emergency trunks proved to be ideally suited for lowering submersible units to pump out flooded spaces, and also served as convenient means of draining upper level spaces into machinery space bilges.

The foregoing implies vertically lined-up hatches within trunks, and ladders one over another, which incidentally requires less space than any other arrangement.

SIZE

ACCESS

War experience emphasized the obvious fact that if scuttles are warranted at all, they should be sized to facilitate personnel traffic wearing wartime equipment such as life belts, etc.; and also that they pass submersible pumps, portable blowers, etc. In this respect the 18" scuttle appears to represent an unrealistic ideal. The 25" scuttle should standard for escape trunks (except when their installation would involve cutting stringers or piercing strength or ballistic decks, where a 21" scuttle should prove to be a satisfactory solution), since these scuttles represent the *only* opening therein, and are fitted directly in decks. On the other hand it appears desirable to standardize on the scuttle as *secondary* openings in normal access, hatches; this size representing a compromise between the conflicting demands of ease of passage and the necessity of increasing hatch strengthening to compensate for increased scuttle size.

All hatches, incorporating 21" scuttles must have no dimension less than 36". Also, to provide a minimum head clearance of 7' on a 69° incline a 42" hatch opening appears desirable. We thus conclude that a 36 x 42 hatch is the optimum size, reconciling adequacy and minimum openings. All normal access routes designed strictly for personnel traffic should be sized accordingly. However, one access route should provide for removing short life components of major machinery items, occasional machinery repair equipment etc. These provisions should be made in a normal as opposed to emergency route because every other consideration permits the emergency route being smaller than the normal route, and the emergency trunk must in fact be enlarged to 3' x 3' merely to take a 25" scuttle. However, this use is so occasional, and so inferior to the every-day wartime desirability of minimum openings, that it is believed a semi-fixed access (such as a bolted plate incorporating the standard hatch) is sufficient. A larger hatch to permit personnel traffic and, say, navy yard ventilation rigs at the same time is unnecessary, as the emergency trunks can be better utilized for the latter rigs; having no inclined ladder interference. Also, time is not of the essence, since ladders and possible between-ladder-platforms would have to be removed prior to use anyway.

Normal trunks would be 3.5' x 4' or 4' x 5' depending on whether more than one level of ladder was required, and hence a return platform for reversing direction between ladder levels. The bolted plates could therefore be sized according to trunk size, but in no case should they be less than 42 x 48.

NUMBER

It is axiomatic that the number of openings should be a minimum, particularly in strength and ballistic decks. This contention was substantiated in the recent war. Moreover, the increasing probability of surprise attack via rocket missiles and craft, and the more potent air-borne dangers incident to developments in radio-active weapons and bacteriological warfare portend even increased emphasis on minimizing openings in future designs. This is true notwithstanding the provisions for an emergency control station, since radiation effects persist; and refuge in the emergency station is to no avail if a surprise attack finds the vessel so opened as to be a prime target for extended internal flooding.

Granting that access is required, the ideal objective is one opening. This follows from the fact that most machinery spaces are below the waterline, and the threat of flooding is a primary reason for minimizing openings. The presence of high pressure steam piping is adequate justification for an alternate access in a major machinery space, since high pressure steam represents the only internally stored potential energy danger. Why this alternate route should extend to the lower level has already been discussed above under “Types.” The size of a space may also justify an alternate opening, where it may be reasonably imagined that conventional damage could demolish or obstruct one and not the other. Generally, size may be considered sufficient to warrant an alternate access only when a space extends the full width of the vessel. Neither “steam” nor size can normally justify more than two access routes. The only factor that might warrant more than two routes would be a consideration of personnel traffic, or more specifically, the number of persons assigned to the space during battle. In this respect possibly an arbitrary time-rate of evacuation would be suitable criterion upon which to base the number of openings. It seems reasonable to predicate evacuation on an instantaneously developed atmospheric condition rendering the space untenable, because such conditions cripple personnel only, and more atmospheric disturbances of this character are envisioned in future conflicts as aforesaid. Conversely, flooding would be a poor index for establishing an evacuation time-rate as flooding time varies too widely, affects material as well as personnel, and most important—is the best argument in the world for less openings.

All things considered, four openings are regarded as the practicable maximum. In the case of three openings the odd access should be of the type extending to the most populated machinery space level. The controlling factor in determining the number of access routes should be that which indicates the greatest number as being required—steam piping, space size, number of persons.

LOCATION

The lower end of the access should be so located as to open into clear or work areas, giving direct and unobstructed routes for personnel, and straight unobstructed bilge “drain and pump” drop. Upper ends should be so located that no two openings from the same lower deck space, open into the same upper level water-tight compartment. Trunks should be vertical, and hatches and ladders should line-up vertically.

Long dimensions should be fore and aft, and scuttles so positioned as to facilitate traffic rather than symmetrically disposed.

When a space has only one access it should be (subject to previous conditions) as close to ship's centerline as possible. Where two access routes are provided they should be located diametrically opposite within the space, with the emergency access route as close to the centerline as possible. Where three access routes are used the two of like character should be port and starboard, and the odd one placed as close to the centerline as possible. Where four access routes are provided two should be emergency access routes and they should preferably be fore and aft on the centerline with normal access to port and starboard. Centerline locations for emergency routes are generally desirable because lower level work areas generally are in or extend to the center, and such locations are more remote to damage from either side, and more remote from flooded pockets due to list of the ship.

CONCLUSION

It is to be hoped that the criteria presented above will be of some interest to operating engineers, as well as prove of benefit to machinery arrangement engineers. The latter should not, however, regard the proposed principles as established and inflexible facts. Machinery arrangement design is an advanced art involving compromises in a multitude of often conflicting intangibles. Such an art can never be reduced to an exact science. However, it would appear that the considerations applied in the foregoing analysis should in any case enable arrangement engineers to more realistically evaluate the cost and effects of compromising certain access requirements. At the same time, a knowledge of these considerations may serve to explain to operating engineers what heretofore might have appeared to them as a lack of accent on access.