**‘ONE HAND FOR THE SHIP’: THE DEVELOPMENT OF ERGONOMICS GUIDANCE FOR ACCESS AND EGRESS**

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**SUMMARY**

Ships are hazardous working environments in which inadequate access and egress arrangements are a leading cause of injuries and fatalities [1]. There is growing awareness that ship design needs to consider the Human Element to mitigate risks to crew safety and Class Rules can contribute.

This paper outlines the development of ergonomics guidance for safe access and egress. It provides a background to the current regulatory environment and demonstrates the need for improved guidance on access and egress in the maritime industry. It outlines the development process including a technical justification of the scope, key criteria and application of ergonomics guidance for improved seafarer safety. It concludes with a critical analysis of the development process and a brief discussion on the challenges facing **rules ergonomists** [2].

*Keywords: Safety, Occupational Health, Slips, Trips and Falls, Falls from Height, Maritime Ergonomics, Access and Egress, Regulation, Class.*

**NOMENCLATURE**

ABS American Bureau of Shipping

BV Bureau Veritas

CSR Common Structural Rules

ECL Ergonomic Container Lashing

ESAE Ergonomic Safe Access and Egress

GBS Goal Based Standards

HEWG Human Element Working Group

HCD Human-Centred Design

IACS International Association of Classification Societies

ILO International Labour Organization

IMO International Maritime Organization

ISO International Organization for Standardization

LR Lloyd’s Register

MEPC Marine Environment Protection Committee

MSC Maritime Safety Committee

POLA Principle of Least Astonishment

PPE Personal Protective Equipment

RHFP Rules Human Factors Panel

SOLAS Safety of Life at Sea

**1. INTRODUCTION**

Access structures and access openings facilitate movement between and within the spaces onboard ship and are essential for effective working and living. However, a ship is a hazardous working environment and inadequate access and egress arrangements are recognised as a leading cause of injuries and fatalities amongst seafarers [1] [3] [4]. The pattern of reported accidents has remained consistent over many years and the hazards facing crews are well-understood [5]. The HE Alert! Bulletin [6] summarises a comprehensive list of principal hazards including:

* Slips attributed to inappropriate deck surfaces with poor slip resistance.
* Trips attributed to abrupt changes in deck level, loose fittings or low-level obstructions.
* Falls attributed to working at height, unstable surfaces, unguarded ladders, platforms or openings, or inadequate handholds and anchorage points.

The maritime industry is gradually putting more emphasis on the need for a safe and secure working environment and there is a growing awareness that the Human Element needs to be considered during ship design to mitigate risks to crew safety. Although, it has been identified that good ergonomics, safe working practices and the suitable provision of protective equipment results in greater awareness and an improved safety culture on ship [7]. The ergonomic design for seafarers is largely not well considered in the marine environment [8], and there is a distinct lack of knowledge in the integration of the human element and systems operational design amongst designers and other stakeholders. To meet increasing challenges for safety and performance, the link between ship design and ship operation has to be re-established and the marine industry must address Human Element concerns more explicitly.

**2. BACKGROUND**

2.1 INDUSTRY DRIVERS

International regulation has been increasingly responsive to the important influence of the Human Element on effective safety standards and practices, and has set out clear aims to improve working conditions for the seafarer community through better ship design. In 2004, the IMO restated its *Human Element* *Vision, Principles and Goals for the Organization* (Resolution A.947(23)) [9] including a specific goal to encourage the development of non-regulatory solutions and their assessment on the basis of human element principles.

There have also been a number of industry initiatives which identify safe access and egress as a particular concern. In 2006, the IMO Human Element Working Group (HEWG), convening at the Maritime Safety Committee (MSC) and Marine Environment Protection Committee (MEPC), noted that P&I Club statistics indicated that more than one out of five personal injury incidents reported were the results of slips, trips or falls [10]. The HEWG agreed that the consideration of ergonomics could result in a significant reduction of accidents in seafarers and subsequently approved an initial *Framework for Consideration of Ergonomics and Work Environment* (MSC-MEPC.7/Circ.3) [10]. The framework identified access structures such as stairs, ladders, ramps, walkways and work platforms as one of five key areas in which the application of ergonomics to design could reduce the incidence of personal injury and human error.

Additionally, in 2010, the IMO Maritime Safety Committee (MSC) adopted SOLAS regulation II-1/3-10 on *Goal-based Ship Construction Standards for Bulk Carriers and Oil* *Tankers* (GBS) (MSC.287(87)) [11] with a view to consider expansion to other ship types and areas of safety at a later date. The standard stipulated that the human element should be considered during structural design and arrangement with the overarching goals of safety of life, safety of ship and safety of the environment. GBS further outlined key functional requirements developed from experience, current rules and regulations and a systematic analysis of hazards and risks [12]. A specific functional requirement (II.9) illustrates the need to consider ergonomic principles to ensure safety during operations, inspection and maintenance, and specifies the provision of adequate means of access.

In response to the establishment of GBS, IACS developed the *Common Structural Rules for Double Hull Oil Tankers and Bulk Carriers* (CSR) [13]. The IACS Council was satisfied that these rules were based on sound technical grounds and achieved the goal of safer ships. However, CSR failed to set out explicit rules for the human element. IACS therefore investigated safe access and egress considerations through the development of the non-mandatory document *IACS Recommendation No. 132 –* *Human Element Recommendations for the Structural Design of Lighting, Ventilation, Vibration, Noise and Access and Egress Arrangements* [14]. Although the document summarises recommendations for the consideration of the Human Element and ergonomics in structural ship design and provides a broad means of compliance, a lack of unified interpretation has prompted unilateral action by Class to address the issue with the American Bureau of Shipping (ABS), Bureau Veritas (BV) and Lloyd’s Register (LR) developing ergonomics rule sets.

2.2 LR’S RESPONSE

In response to the identified risks and hazards to seafarer safety and the increased industry drive to consider the Human Element within maritime regulation, LR has developed a strategy to address the Human Element. In 2003, an analysis of Class Rules and associated documents found a large number of implicit Human Element requirements [15]. In this analysis, Antonio and Earthy [15] concluded that in order to be of value, Human Element requirements in Class Rules need to be stated explicitly, consistently and to define the intended operational context in which they applied. Classification Rules and Regulations are the main means of mitigating error in design construction of ships [2]. Class Rules also provide a means of assurance and verification for the application of ergonomics. Hence, the inclusion of ergonomics requirements within Class Rules has the potential to make a credible impact and far-reaching improvements to safety on a large scale. The findings of the analysis resulted in the revision of rule requirements and the development of specific ergonomics rule sets [2].

The Ergonomic Container Lashing (ECL) notation was the first new physical ergonomics rule set to be approved by LR [8]. ECL was among the first rules products designed to mitigate against occupational health hazards, its primary goal to improve the safety of working arrangements for port workers and ship’s crew when performing container securing, inspection and other related tasks. In developing ECL, Walker noted a particular challenge in translating from the task-based language of ergonomics to the prescriptive language of rules and requirements [8]. To ensure the development of criteria that are ergonomically sound, technically clear and assessable, Walker determined that ergonomics guidance must:

* Be prescriptive in order to provide clear unambiguous instructions to designers and manufacturers.
* Be defensible and of scientific merit in order to withstand challenges by stakeholders.
* Be written in simple language that is understood by non-ergonomists.
* Be verifiable such that compliance assessment is straightforward.

An awareness of the challenges faced in developing and gaining approval for the ECL notation provides a basis for the development of new ergonomics rule sets.

**3. RULES DEVELOPMENT**

In order to address the specific risks and hazards associated with access and egress, LR has developed a *Guidance Note for Ergonomic Safe Access and Egress*.

Class Rules communicate the requirements for minimum safe design to be satisfied for the consideration of Classification. However, there also exist Class products which offer optional requirements which Class can apply on behalf of an owner or shipyard as necessary. Notations stipulate additional requirements which enhance the minimum tolerable level of safety or provide assurance of performance in defined circumstances. Notations describe the ship and its appraised aspects and are appended to the character of Classification for the purpose of providing additional information of a ship’s design and construction. On the other hand, Guidance Notes are complete documents which provide further explanation, clarification or technical recommendations on a specific topic supplementary to the Rules, their application may too be recognised by the award of a Notation.

A Guidance Note structure is adopted for the consideration of access and egress in order to best present this large body of material and provide a complete reference text and resource.

3.1 SCOPE

The scope of the Guidance Note is broad and aims to provide a ‘whole ship’ solution to access and egress design. Although a sweeping approach may risk industry resistance and places some restrictions on the level of description possible, it is adopted to ensure consistency is maintained across access and egress structures on a shipwide basis.

Design guidance is provided for a comprehensive range of commonly used access and egress arrangements on ship including:

* Access Structures – stairs, vertical ladders, inclined ladders, individual rung ladders, ramps, walkways, work platforms.
* Access Openings – doorways, hatches, manholes, scuttles.
* Access Control – doors, hatch covers, manhole covers.
* Safety Devices – handrails, guardrails, safety rails, safety cages, safety cables, fall arrest devices.
* Signage – safety signs, safety markings.

The Guidance Note stipulates that the design of permanent access structures and access openings should facilitate safe movement between or within the spaces onboard a ship. It should also allow suitable access for inspection, and maintenance tasks in spaces which are normally occupied, and inspection, survey and maintenance tasks in space which are not normally occupied. However, it should be noted that the guidance note does not provide explicit recommendations for emergency egress in the case of fire as this subject is extensively considered within the International Code for Fire Safety Systems [16].

The Guidance Note is not a re-examination of ship safety. It closely follows and extends some aspects of the design recommendations outlined in IACS Recommendation No.132 in order to maintain alignment with existing standards for access and egress. A significant amount of research was conducted in the development of IACS Recommendation No.132 and it provides a good basis for Rule development. The Guidance Note also complies with relevant statutory regulations except where it is deemed appropriate to raise the base line for safety on board ship by presenting more rigorous set of safety criteria.

The rationale for the consideration of ergonomics in the design of access and egress arrangements is based on the integration of safety and task performance. The Guidance Note considers physical ergonomics with recommendations for access structures, openings, control and safety devices designed for the expected range of anatomical, anthropometric, physiological and biomechanical characteristics of the ship’s crew. The Guidance Note also considers cognitive ergonomics from the perspective of signage. Finally, the guidance addresses the context of its application and operational use, such that it encourages a shift in the perspective of design from the arrangement of structural elements to considering access structures as links between the spaces used by seafarers in working and living on the ship. From this perspective it is much easier to see the link between design and operational safety and performance. These contextual considerations are built into the guidance offering a ‘multiplier’ on ergonomics expertise for the designer.

3.2 SHIP TYPES

The Guidance Note presents general guidance for access and egress in order to provide a flexible accreditation route which will be applicable to a wide range of ship types. Cargo ships (32%) together with passenger ships (30.1%) are the main categories of ship where occupational accidents occur [1] and therefore represent a primary focus. The Guidance Note may also be applicable to special service craft, but is not currently deemed applicable to naval vessels or offshore vessels and installations due to the varied nature of their operational requirements.

3.3 STAKEHOLDER REQUIREMENTS

To ensure the use of the Guidance Note it is important to gain acceptance from both internal and external stakeholders. There are many stakeholders concerned with the safety of seafarers and ships in relation to access and egress. However, the links between them are often complex and variable requirements present a unique challenge to the development of ergonomics regulations and recommendations. The contractual environment in particular has not favoured consideration of human element issues in the past [17] due to increasing commercial pressure on both design and legislation. Key stakeholders include:

3.1 (a) Designers

Naval architects and marine engineers have a professional obligation to act in the best interest of seafarers to assure their health and safety [12]. Traditionally, naval architects addressed safety through the subjects of speed, strength and stability with the belief that adequate safety was achieved through compliance with Class Rules and Regulations. However, investigations into recent maritime accidents have highlighted the impact of the Human Element and ergonomics on safety level [12]. The problem arises where naval architects do not have the proficiency to analyse context of use or apply ergonomics principles and as such require precise recommendations and design rationale which do not require external expertise or interpretation.

3.1 (b) Shipyards

Shipyards are a critical stakeholder as this is often the body which chooses the Classification Society [8]. It is the shipyard’s responsibility to ensure that a ship is built to the required specifications in line with regulation and Class. Shipyards are often reluctant to consider significant changes to current designs in case they increase the cost of build. However, ergonomics rule requirements do not need to be complex and can often be implemented (at least partially) through simple prescriptive rule sets to which will enable better quality assurance and improve efficiency long term.

3.1 (c) Owners

The ILO states that owners have a professional obligation provide and maintain ships in such a manner that, as far as is reasonably practicable, there is limited risk of accident or injury to seafarers [18]. The ILO [19] also emphasizes that ship owners should ensure that design of their ships takes account of ergonomic principles and conforms to relevant international and national laws, regulations, standards or codes of practice in order to achieve this goal. However, owners still need to be persuaded that the benefits of applying ergonomics recommendations outweigh initial and through-life costs. In addition to their professional and ethical obligations, it may be beneficial to emphasise to owners that there are financial implications associated with injury and fatality. The UK P&I Club has reported a rise in personal injury claims in recent years which has a direct impact on liability and premiums [3].

3.1 (d) Crews

Crews have a right to expect a safe and secure working environment which is operational and adequately protected from hazards [18]. Crews also have a right to expect that the ship will be well maintained throughout its lifetime to ensure safe working conditions are upheld [18]. However, crews must actively participate in ensuring safe working conditions are maintained. Crews are expected to take care of their own health and safety by following ship safety procedures and using the personal protective equipment (PPE) and clothing at their disposal [19]. Requirements also exist for inspecting, reporting and correcting unsafe conditions [19]. The NIOSH Hierarchy of Controls (Figure 1) [20] explains that over reliance on administrative controls and the provision of PPE are least effective in safety assurance. There is a requirement for hazard elimination, substitution or isolation via engineering controls which most easily implemented in the ship design phase.

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Figure 1: Hierarchy of Controls [20]

3.1 (e) Class Surveyors

Plan approval and field surveyors may be required to verify ergonomics requirements and recommendations. However, surveyors are trained to make judgements about engineering, not human behaviour [8]. Ergonomics recommendations that are not structurally defined cannot be easily verified on plans, hence, surveyors need to be provided with clear verifiable recommendations or alternate means of approval need to be made explicit. Additionally, if surveyors are expected to verify human element requirements and recommendations, a suitable training provision needs to be implemented to equip them with baseline knowledge of the subject [2].

3.1 (f) Regulators

Regulators stand to benefit from the success of non-mandatory frameworks such as a guidance notes or notations which can provide an evidence base or mandate for subsequent mandatory or statutory schemes to be implemented.

It is clear that the safety culture and economic pressures within stakeholder organisations have a significant effect on ship design, maintenance and operation [12]. The analysis of the stakeholder environment further illustrates the need for clear prescriptive guidance. Additionally, it highlights issues around the use of specialist terminology which can be misunderstood or vary within and between organisations and from ship to ship. All terminology used within the guidance note is consistent and clearly defined to ensure that essential safety issues are readily and reliably communicated both within and between organisations [12].

3.4 DESIGN CHALLENGES

A number of design challenges emerged during the development process of the Guidance Note. The following are some examples of specific challenges encountered in the development of ergonomic criteria for access and egress:

3.4 (a) Access Structures

The consistency of access structures plays a significant role in preventing accidents and injuries. For example, even small differences in the rise or going between adjacent steps can cause a misstep or fall. Consistency also plays a vital part in meeting user expectations. Human beings make mental models of everything of the they encounter and create patterns of behaviour based on interaction and experience [21]. If a structure meets expectations and corresponds to the mental model, there is more chance it will be used as intended and less chance of accident or injury. The Guidance Note therefore recommends consistency for the design of access and egress structures on a shipwide basis to increase usability and decrease instances of human error. It adopts a principle of least astonishment (POLA) which typically applies to user interface and software design [21] but has applications in structural design and significant implications for safety.

3.4 (b) Access Openings

The consideration of access openings presented a particular challenge to the development of recommendations for safe access and egress. The Guidance Note considers anthropometrics in the development of prescriptive recommendations to make provision for the range of variability anticipated in the expected user population. However, for the maritime sector, this becomes increasingly complex as the global nature of the industry is such that the expected user population is extremely variable. The employment of multi-national, multi-cultural and multi-lingual crews is commonplace [7] and the wide range of human variability and adaptability have led to conflicting practices worldwide. In particular, difficulties arise due to a failure to recognise differences in global anthropometry. Walker [8] observes this phenomenon in the development of ECL noting difficulties in ‘(convincing) designers in Asian yards for the need for sufficient headroom’.

Current specifications and locations for access openings, particularly for the purposes of inspection e.g. in double bottom, are insufficient for the majority of the global population, especially where persons are required to wear protective clothing or use breathing apparatus. The Guidance Note recommends adequate sizing for safe practical use.

3.4 (c) Access Control

The prevention of confined space deaths has been a growing concern for maritime industry. During the development of the Guidance Note, it was determined that good access control has a significant impact on crew safety, particularly in the prevention of entry into hazardous spaces. A confined space may be defined as a space which is not designed for continuous occupancy, where access is limited, where there is poor or no natural ventilation, and which may contain dangerous equipment or atmospheres [22]. However, in many cases confined spaces are not always easily identified and some have freely accessible openings for entry and exit with limited access control. For example, many hazardous spaces such as paint and chemical lockers, CO2 and battery rooms can be entered through unlocked weathertight doors. The Guidance Note therefore recommends the use of appropriate access control devices in order to limit access into hazardous spaces including the provision of covers, mechanical closings, interlocks, and appropriate signage which makes clear any hazards and specified entry protocols.

3.4 (d) Fall Protection

The provision of fall protection arrangements is essential to prevent slips, trips and falls and in particular falls from height. However, fall arrest devices are typically used as first line of defence in fall protection. In contrast to this practice and acknowledging that this represents a change in the industry, the Guidance Note recommends fall elimination as the preferred method of fall protection with recommendations stating that working at height should be avoided where operationally possible. Guidance for fall protection arrangements and devices employs an adapted four-tier hierarchy of fall protection controls (Figure 2) for improved safety. This four-tier hierarchy of fall protection controls is categorised by:

* Fall elimination - the arrangements which facilitate the completion of required tasks without persons entering fall hazard areas.
* Fall prevention - the arrangements or devices which protect against the fall of persons including fencing.
* Fall restraint - the devices or personal protective equipment (PPE) which prevent the fall of persons including fall protections devices such as safety cables.
* Fall arrest - the devices or personal protective equipment (PPE) which provide the safe stopping of persons already falling including fall arrest devices.

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Figure 2: Hierarchy of Fall Protection Controls

It should also be noted that statutory requirements for fall prevention in ship design do exist within the International Convention on Load Lines (Regulation 25) [23]. However, this Convention only requires the provision of a low-level guardrails to prevent persons being swept overboard. In general, these requirements are sufficient for safe access and egress purposes, but, where fencing is in place for fall protection purposes the convention does not apply, and more appropriate ergonomic standards may be adopted. Fencing requirements to prevent falls from height are well-established for shore-based industry and there is strong evidence base for the incorporation of such requirements into the ship design process [2].

3.4 (e) Signage

The provision of guidance around safety signs and safety markings is a novel addition to the scope of the Guidance Note. It can be argued that for safety to be assured, the ergonomics of communications systems must also be considered including the provision of adequate signage in a language appropriate to the native languages of all onboard [7]. Recommendations for the provision of signage are provided within the Guidance Note with the purpose of facilitating the safe use of access structures, highlighting hazards to reduce the risk of slips, trips and falls, and controlling access to hazardous spaces. The Guidance Note presents a ‘marinized tailoring’ [17] of ISO standards for signage [24] that are widely applicable in other sectors and used effectively within terrestrial architectural practice. The Guidance Note also makes normative *ISO 24409 Ships and Marine Technology – Design, Location, and Use of Shipboard Safety Signs, Safety-related Signs, Safety Notices and Safety Markings* [25] which presents recommendations specific to the maritime industry, and provides guidance for its appropriate application in the context of ship access structures and arrangements.

3.5 APPLICATION

The *Guidance Note for Ergonomic Safe Access and Egress* provides an optional framework for best practice leading to enhanced ergonomics and improved safety. The accreditation of the Guidance Note is an important consideration from the perspective of uptake, as stakeholders will desire recognition for the appropriate application of ergonomics considerations. It is intended that the application of guidance note will result in the award of an optional Class Notation ESAE. It is also determined that survey requirements for assigning the ESAE Notation and for maintaining it though life will be fulfilled through the provision of a manual for safe access. The manual will be provided for initial plan approval and retained onboard for further reference at periodical survey to ensure compliance against the notation is maintained. The manual for safe access will contain:

3.5 (a) Ship particulars and specification

Ship particulars and specification provides information of type of ship and identity.

3.5 (b) Access operational concept

The access operational concept is a verbal and graphic statement of design intent with regard to the operation of the ship. It is a user-oriented document that describes a designer’s understanding of the users’ needs and how a system will operate to fulfil those needs. The operational concept framework is typically used within systems engineering [26] and is an effective tool to establish a link between ship design and ship operation. The access operational concept should describe the form and use of access and egress arrangements with the ship ‘system’ and describe a strategy for access and egress through a statement of design rationale. In general, it should include:

* A statement of the goals, objectives and motivations of the systems together with the strategies, solutions, tactics, methods, and techniques used to accomplish them.
* A statement of the boundary conditions and constraints of the system. For example, there may exist a constraint on the hours of operation of the system, a constraint on the number of personnel available to operate the system or a constraint on operational facilities or space.
* A user profile including responsibilities, education, background, skill level, activities, and modes of interaction with the current system.
* A description of the system including the operational environment and its characteristics, major system components and the interconnections and interfaces, performance characteristics and attributes, such as speed, frequency, flexibility, maintainability, portability, and usability and operational risk factors. Provisions for safety, security, privacy, integrity, and continuity of operations in emergencies.
* A graphical overview of the system. This can be in the form of any type of diagram that depicts the system and its environment.

3.5 (c) Ship general arrangement

The general arrangement gives an overview of the whole ship access and egress strategy. The current convention is to present the general arrangement of a ship via plan and profile views. However, it is counterintuitive to design access and egress requirements in plan and this practice is rarely seen in terrestrial architectural design. It is recommended that sectional views should be included as part of the general arrangement provision.

3.5 (d) Structural details

Plans and sections showing the permanent means of access to/from and within each space with appropriate technical specifications and dimensions.

3.5 (e) Inventory of permanent means of access

The inventory of permanent means of access should group means of access together into operational systems and include information on any features relevant to the ergonomic design of the access structure.

3.5 (f) Records of inspections and maintenance

The records of inspection and maintenance should include as a minimum the date of the inspection, the name and title of the inspector, the means of access inspected, verification of continued serviceable condition or details of any deterioration or substantial damage found [27]. This is vital for both ship safety through life and approval by Class.

3.5 (g) Records of change to permanent means of access

All changes to permanent means of access should be recorded. Major changes may require revision of the manual of safe access and will be subject to review and/or re-approval by Class.

The provision of a manual for safe access is in line with goal-based standards which stipulate design transparency [11], a specific functional requirement (II.10) states that ships shall be designed under a reliable, controlled and transparent process made accessible to the extent necessary to confirm the safety. The manual of safe access is a clear record of design intent and has subliminal human factors applications in providing a vital link between design requirements and operations. Additionally, in aligning ergonomic design principles with naval architecture standard practice and nomenclature in this way ensures human factors guidance is easily understandable and more credible in an operational framework.

3.6 CRITICAL EVALUATION

The Guidance Note was developed under a governance procedure that ensures the development of criteria that are ergonomically and technically sound, unambiguous, assessable and acceptable from a commercial point of view. Both the concept and the resulting work were reviewed by an independent, external body, the Lloyd’s Register Rules Human Factors Panel (RHFP).  The RHFP benefits from expert members from a wide range of marine industry stakeholders. The RHFP also designated mentors to provide advice to the project.

In order to identify and take account of requirements and feedback the project approach was iterative, and user centred. Rather than working from first principles the project derived technical guidance from international and industry standards. This material has already been through a rigorous review process and usually specifies the context in which the guidance is valid. In addition to the technical content, the user requirements and the document architecture were reviewed to validate value and user experience respectively. The first draft was reviewed by ergonomists and Rules experts, and following revision was submitted for formal technical review by internal and external experts in naval architecture, structural design and Class survey. This is the first formal step in the Lloyd’s Register Rules approval process.

**4. CONCLUSIONS**

This paper presents an overview of the process of developing ergonomics guidance for safe access and egress. The paper illustrates many opportunities and challenges in the application of ergonomics within Class Rules. Addressing ergonomics through Class Rules has the potential to provide a wider benefit than consulting activities can provide. However, successful application of ergonomics requires working within the constraints of the maritime industry in order to make a tangible impact. Ergonomics continues to face scepticism from industry stakeholders who question its cost benefit; and the design community who question its value, reliability and validity [28]. Challenges also exist in raising human element competence for designers and surveyors [2].

It should also be recognised that the development of the Guidance Note is just the first step in operational safety. In order to achieve more effective safety assurance, designers, ship owners and operators will need to look beyond recommended arrangements and dimensions and adopt a goal-setting methodology to take account of hazards that are not adequately addressed through prescription [12]. This becomes increasingly important as new technologies emerge, and designers need to request derogations from Class. In cases of derogation, the designer is be required to present an evidence base to show that access and egress arrangements are safe. Lloyd’s Register’s development of procedural guidance on human-centred design (HCD) [17] [29] [30], is a good example of how guidance may be applied to novel designs to facilitate the integration of human factors for improved safety.

Additionally, the Guidance Note and associated Notation only goes one step towards a complete consideration of enhanced ergonomic design for improved safety. There is a case to be made for a broader notation to cover the full range of ambient environmental considerations covered by IACS Recommendation No. 132 including lighting, noise, ventilation and vibration. However, the successful application of the Guidance Note for Ergonomic Safe Access and Egress is a first step to secure wider industry interest.

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