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| IALA Guideline |

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Human Factors and Ergonomics in VTS

As revised at ICG 1 June 2021

Points covered at ICG 1 Sept 2021:

• Expand the role of trainings and other general applications of HF activities, not to get focused on technical factor only.

• Proper balance between high-level definitions and practical examples of the role of HF for VTS. "Explanatory descriptive" parts to be reduced, moving ahead to the role and the directions of HF application. Also, define human problems to be resolved, instead of too detailed requirements/recommendations, but for practical purpose (and not to be too abstract/academic) we can use Appendixes with checklists examples. It is especially relevant to technical factor.

• References to HF in aviation and ATC are okay, but we should avoid claims of being too direct in borrowings — the subject domains are both similar and different.

• Currently different parts of the draft miss necessary connection between them. It should be resolved to get integrated, consistent document.

Edition x.x

Date (of approval by Council)

Revisions to this IALA document are to be noted in the table prior to the issue of a revised document.

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# INTRODUCTION

## BACKGROUND

IALA conducted a workshop on Human Factors and Ergonomics in VTS at Chalmers University of Technology in Gothenburg, Sweden (12 - 16 October 2015), in conjunction with Chalmers University of Technology, the Dutch VTS Operator Training Foundation and the Port of London Authority. A conclusion of that workshop highlighted the need for guidance on raising awareness about safety culture and human factors, including incorporating the work into existing and developing IALA documentation.

The IALA VTS Committee has been tasked with developing guidance on human factors and ergonomics in VTS. The objective of this task is to provide awareness regarding the role of the human factor in the performance of a VTS to competent authorities and VTSOs. In addition, this guidance would support the implementation of human factors in the training cycle of initial training, sector training, recurrent training, updating training and adaptation training.

This document builds upon previous work to further develop VTS guidance on human factors and ergonomics. Within the scope of this work the VTS is identified and understood as a complex socio-technical system where operators, organization and technology and the interactions between them play a crucial role for quality, safety and efficiency of VTS services. Human factors and ergonomics here is understood as a framework that can help to categorise information about work and work settings, how to collect information about a work setting, what to do to make it better, and how to explain and measure the possible benefits to the change.

## AIMS AND OBJECTIVES

This Guideline provides awareness regarding the role of the human factor in the performance of a VTS. It is intended to present a source of information to assist Competent and VTS Authorities in the preparation and implementation of systems to support improved operational performance. It is not intended to provide specific information on the safety culture or portrayal of data.

Furthermore, this guideline provides guidance in implementing human factors in the training cycle of initial training, sector training, recurrent training, updating training and adaptation training.

# VTS as socio-technical systems

Traditionally, technological advancements have been a driver for research and development activities in the VTS domain. Thus, many activities have foremost focused on the development of technical equipment and information sources within the domain. However, in the past 15 years an increasing body of work has taken a human factors approach rooted in a socio-technical systems perspective to increase the understanding for interactions across operators, technology and organization. In recent years, an increased focus on future VTS operation and the potential of human-autonomy interactions within shore operation centers has developed.

VTS can be considered as a socio-technical system where operators provide services to a larger variety of customers. While staffing and local organization might differ, VTS is very often, but not always, part of a port system including VTS, pilot, tugs, ship/s and crew/s. Studies have shown that all the actors in this system need the same information but perhaps at different levels of granularity. Thus, coordination and cooperation among the different actors within the port system becomes a key for the service’s quality, and the overall safety and efficiency of traffic movements within the area.

Figure 1 draws attention to the complexity of the work environment for VTS operators. The operator provides information services in an area that is located on the port entrance of one of northern Europe’s largest ports. Within the center the operator is collocated with operators for the pilotage ordering service and the port. Thus, information for service provision can be gained both through the decision support system, VHF radio and from other services.

[add in a generic diagram (human with labelled screens – different sectors, VHF comms control, shipping movements, phones, log…]



1. VTS Operator in northern European VTS centre

For the service provision to the vessels, the information from all the different sources available are merged by the operator thus drawing attention to both physical, such as proximity to other services or workstation layout, and cognitive aspects, e.g. decision making, interpretation of current traffic picture in the VTS area, of VTS everyday work. Therefore, the operator’s expertise and experience based on technical and non-technical skills become crucial for the service provision . In addition to the physical and cognitive aspects of the work, the organizational framework of the VTS, including training, service and staffing levels, operational procedures and integration with other services, also shape the precondition of work.

## Characterisics of a socio-technical system

Table 1 presents an overview of the characteristics of VTS as a socio-technical system. As there are many different organizational, human and technical aspects to the VTS operations, human factors and ergonomics become an important facilitator to design a system that is able to balance quality, safety, efficiency and economic aspects of operations.

1. Characteristics of a socio-technical system (adopted from Vicente, 1999) applied to VTS

| Characteristic | **VTS** |
| --- | --- |
| Interactions of various layers | VTS interactions with vessels, allied services, general public  [perhaps look at different aspects of ‘layers’ – operational, regulatory, equipment] |
| Large problem space | Complexity of everyday work based on uncountable number of variables (ship-related, environmental, geographical etc.) |
| Dependence on communication and coordination | Multiple means of communication  VHF as main means of coordination through communication between vessels and shore  Phone, email VTS and allied services |
| Distributed | [VTS personnel operating in co-located / different centres, communicating to each other] |
| Dynamic | [ship moving independently]  Bring in concept of dynamic elements in VTS (weather, geographic constraints, hydrographic]  VTS personnel – multiple duties  Equipment provided, changing (evolving) interfaces. |
|  |  |
| Couplings | Complex net of technical, human and organisational functions |
| Automation | decision support system  technical innovation  developments affecting VTS (i.e. MASS) |

# Human factors and ergonomics

Human factors and ergonomics (HF/E) describe the scientific discipline and domain of practice concerned with the understanding of interactions among humans and other elements of a system. Human factors and ergonomics as terms are used interchangeably along with user experience. Human factors are often referred to in American settings, while the ergonomics is more commonly used within Europe. In this document we will use the term Human Factors.

Human factors applies theory, principles, data, and methods to design in order to ***optimize human well-being and overall system performance***

Human factors is a systems approach to understand human work in complex environments. As approach, HF/E is holistic and concerns the design and evaluation of tasks, jobs, products, environments, and systemstaking into account physical, cognitive and organisational factors (fig 2).

Work and work settings are analysed taking human operators, systems and work environment into concern.



1. Three main areas of human factors (adopted from International Ergonomics Association ( IEA)

Cognitive factors include functions related to: perception, memory, reasoning and motor responses, human-computer interaction, communication, and teamwork.

Physical factors relate to: human anatomy, physiology, anthropometrics and biomechanics.

Organizational factors relate to: operating procedures, shift schedules, administration, regulations.

Each of these factors have overlapping areas which need to be considered in interactions within the operational environment.

## Human - Technology - Organization (HTO)

The human-technology-organization is an analytical framework within the human factors domain. The approach is rooted within the nuclear power domain. It was in the late 1990s as a response to the increasing need to create a deeper understanding for the complex interplay between human operators, technology and organization in safety critical operations . The HTO perspective emphasizes the importance of understanding the interactions and interdependencies between a sociotechnical system’s human, technical and organizational parts. Since the late 1990s this perspective has gained an increased acknowledgement and is now applied across many different industries.

Within this document, we suggest adopting a H-T-O perspective with specific focus on system performance can be understood and support operator well-being. The benefits of applying an HTO-perspective to system design and analysis are exemplified in figure 3. The figure shows potential improvements in three categories; Human, Technology and Organisation.

Human:

* Improved wellbeing of staff
* Improved effectiveness of personnel
* Improved communication
* Safety work conditions (physical and psychological

Technology:

* Support tasks – effectiveness and efficiency
* Increased efficiency in equipment and tool use
* Improved training and procedures
* Fewer errors

Organisation:

* Increased productivity and effectiveness
* Improved management of risk
* Reduced costs for training and service provision
* Increased safety



1. Figure 3: Potential benefits of HTO-approach (adopted from ??)

Adopting an HTO to the VTS, may help to structure discussions on how (work) environment, technology, operator and organization are coupled to each other and emphasize the need to acknowledge the interactions and interdependencies among these shape the precondition for safe and efficient service provision in the VTS domain.

## Human centric design

The design intended to consider human particularities and be effective and safe is the iterative process that is constantly checked across human factors criteria. Typically, it includes these important steps: conceptual design, improvement of details, internal verification and validation of decisions with potential users and operators (feedback gathering) with further active response to the gathered feedback.

Figure 4. The Process of Human Centric Design

### Requirements gathering

During this step all the requirements for the system are gathered from stakeholders and other sources:

1. Business requirements and high level goals of the system — the definitions of the system purpose across all the stakeholders. For human factors design It is critical not to forget about the end-user (operator) goals and concerns.
2. Functional requirements — the requirements to system functions, workflows and dataflows, typically defined as use cases or usage scenarios. Roles of users are also defined.
3. Non-functional requirements — specific requirements and constraints that affect the performance of the system
4. System requirements — technical requirements to the implementation of the system

### Conceptual phase

During conceptual phase all the requirements gathered are analysed and the conceptual design of the system (layouts, workplaces, drafts of user interfaces that affect primary workflows and scenarios) is prepared.

The purpose of the conceptual phase is not to create a complete and detailed design of the system, but to define birds-eye view of the vision for further discussions, approval and improvement.

Good concept highlights the principles of human centric design:

1. How the system interacts with users/operators and helps to reach both their goals, goals of stakeholder and internal goals of the system.
2. How the overall safety and optimal performance of the humans is supported, what are the fundamental and consistent ideas and principles across all the system design to help humans to learn the system, interact with it, avoid mistakes, respond in mission-critical situations, etc.

### Details improvement

This is the phase during which all the necessary details are defined, and the whole coverage of the scenarios, requirements, technical aspects is considered and implemented in the design of the system.

Details improvement phase is typically iterative and split on functional blocks (modules).

The ideas of the conceptual phase can be reviewed and scaled, but for human centric approach it is critical to support overall consistency with all the relevant principles, defined in the system concept.

### Verification/validation with user research/interviews

All the decisions done during the previous phases are to be verified internally for human factors and validated with real users and operators. This guarantees that they are not isolated or irrelevant to particular aspects of human factors and ergonomics, and that sufficient feedback is gathered.

Basic methods for verification include:

1. Checklists and heuristic analysis
2. Corridor tests
3. Cognitive walkthrough

Typical methods for validation include:

1. User interviews
2. Field studies
3. Moderated and nonmoderated usability tests

Check APPENDIX X for the more detailed list of methods

Verification and validation for human factors are not a single “did-and-forgot-it” activities, it is recommended to perform them consistently during the whole lifecycle of the system, especially when there are major changes in design, regulations, or after incidents occurred.

### Response to the feedback

As a result of verification and validation, all the responses and the outcomes from the feedback are reviewed and used for further improvement of system design.

### Installation and operator trainings

The deployment of the system is a major step concerning efficient usage from the human factors perspective. It is not enough to set up the system and deliver operational manuals across operators — specific trainings are to be organized, covering all the aspects of both subject domain scenarios, interaction with the system, daily and emergency procedures, considering the human factors, like fatigue, and their management, that described in the ongoing sections of this Guideline.

# Human Factors in VTS operations

As aforementioned, VTS can be considered as a complex socio-technical system. There are multiple aspects, which may affect operator work, system performance and operator well-being. The following table presents key areas to address within the design, evaluation and assessment of VTS systems based on the HTO framework.

To acknowledge the difference between VTS systems world-wide, a fourth category, Environment, has been added to the list below as service provision, service level and demands may vary.

These factors are taken into consideration noting the VTS Operational area, including the area specific aspects of the fairway, traffic, meteorological and hydrographic elements.

1. Human factors in VTS

| Category | **Key Areas to Address** |
| --- | --- |
| Human | * Performance measures and shaping factors (workload, stress, fatigue) * Attitudes and commitment * Technical (expertise/operational experience, e.g. conflict detection and management, service provision) and non-technical skills (communication, decision-making, situation awareness/sensemaking, leadership, teamwork, task management, problem solving, creativity) |
|  |  |
| Organization | * Preconditions for work (work schedule, staffing, selection criteria) * Resilience/High Reliability * Procedures – SOPs etc. * Training provision   + Training needs analysis   + Assessment and evaluation techniques   + On the job training * Safety and quality management   + Appraisal procedures   + Reporting system (e.g. incidents/accidents) and follow-up procedures including organizational learning * Workplace design   + Workstation design   + Physical workstation arrangements/spatial design   + Light, noise, temperature * Operational environment/ service integration within port system |
|  |  |

# Human factors in VTS

This section covers human factors, that affect vessel traffic systems performance, safety and efficiency.

## Human factors affecting the system

Humans differ from machines by nature, they have their own particularities that affect the overall organisation, and pure engineering approach is not working, The way to blame the operator for error after incidents is obsolete — proper consideration of human factors during VTS planning, design, implementation, deployment and trainings leads to the increase of efficiency and drop of incidents rate.

For proper approach, understanding of particularities of both humans and machines is needed.

### Human particularities

#### Perception (inputs — vision, etc.)

Humans get the information from external world by sensory inputs. The most critical are vision and hearing, because most of the information is received by them, while other senses, like touch and smell are also important, but are used less consciously (for instance, touch helps to quickly identify hardware controls without waching on them, while smell is critical to identify hardware failures because of short circuits or before to respond to fire before it is too late)

Every sensory input has its own particularities, possibilities and limitations.

It is critical to consider the relative bandwidth — the limitation of the information, that can be perceived in time, but compared to the machines, it differs depending on the circumstances and human state (tiredness). If there is more information provided, than current bandwidth allows, the human can get overloaded, and critical signals will be ignored.

#### Means of action (outputs — muscles, voice)

Humans interacts with external world with their muscles, including voice. For VTS these are mostly manipulations with hardware (dedicated buttons, keyboards, mouse and touchscreens) and changing the position to get better access to specific input and output devices.

Basically, there are two types of actions: gross motor skilled actions, that require less efforts, and fine motor actions, that require more attention. Typical examples of fine actions include pointing to specific area on the display with mouse, while gross motor actions are for using swipe gestures on touch screens. Properly designed workflows and layouts considering these types of actions allow to increase the speed of interaction and avoid fast fatigue.

#### Memory

Human memory both with cognition is critical for decision making. There are three types of memory:

* Short term — very fast compared to other types, but has low volume and duration, that affects the amount of perceived information we are able to process at a moment. The information in it is easily replaced with new inputs, and typically we don’t recognize that something is lost
* Mid term — this memory has more volume, but it is harder to access. Can be subject of multiple distortions and biases. It helps to keep the overall context of the situation
* Long term — the knowledge that we have. Can be fast, but requires regular updates to be used effectively. Also it Is easier to put the information with strong emotional connection into the long term memory, what is critical for trainings — it is naïve to expect, that a single formal training will be enough for further effective work process.

#### Cognition

[how these elements affect cognition / processing of information]

* 1. **Single focus of attention**Humans are not able to perform several tasks simultaneously, it is possible only to switch with relatively slow speed between tasks, depending on their complexity. Also, under stress, the focus on specific (recognised as critical) task can lead to “tunnel perception” — any other inputs can be ignored, even if they are distinct, strong and lead to dangerous situations. There are multiple examples [15, et al] of incidents caused by this reason.
  2. **Learning curve and automated actions by reflexes**  
     Some time is needed to start using the system in the most effective way — conscious actions are transformed into subconscious, automatic actions, that are based on the mechanics of conditional reflexes. It can significantly increase the speed, but reflexes can lead to their own issues, because they result in loss of conscious awareness.
  3. **Fatigue**  
     Long activities, especially monotonous ones, decrease the efficiency of the humans because of fatigue, that affect all human capabilities: perception, cognition and decision making, response etc. Multiple incidents across all industries are caused by fatigue and improper fatigue management at organizational level.
  4. **Stress**  
     Stress is a situation of internal resources mobilization under the threat of dangerous consequences. In short term, it can significantly raise the efficiency of operator, but right after it the efficiency decreases significantly because of fast fatigue. As it was mentioned, stress can also cause tunnel perception.
  5. Definition of human errors (different types, like slips)  
     Humans are prone to errors, that have multiple reasons and nature. The following types of errors are identified [9]:
     1. Slips of actions (“not doing what is expected”)
     2. Lapses of memory (“forgetting to do something midway through the task”)
     3. Rule-based and knowledge-based mistakes (“decision making failures”)
  6. **Biases**  
     Biases are connected with the “mistakes” type of the error, and they are based on multiple perception and cognition particularities, that are based on human evolution mostly. Basically, biases are based on “survival best-practices”, but they tend to affect the performance in the irrelevant situations, that are not recognized as such. Informing about cognitive biases is a critical step for protection, but to avoid them completely requires systems approach, including proper organization and design of the system etc.
  7. **Situational awareness**  
     Situation awareness is the internal representation of current dynamic situation, that Is based on perception and cognition, including understanding of current state, understanding of its trends and prognosis of future events and activities. For VTSO it is critical to keep proper and adequate situation awareness by proper inputs from technical means, cross-checks with other operators and stakeholders, regular updates and proper analysis and decision-making procedures.

## Machine particularities (inputs, outputs, processing)

* Human-centered design
  + User needs
  + Information presentation/representation
  + Level of automation and human-automation interaction

Information structure and integration of sensors within the VTS system

## Context of VTS System

## 

### Subject domain

Subject domain defines multiple formal and informal aspects of VTS system:

* Language that is used (including standard terms, phrases, professional slang etc.)
* Regulations and procedures
* Informal traditions (???)

### Environment

### Organizational

* 1. Resource management

# Ergonomics

[headings to be determined]

[what to consider for a VTS centre to provide the environment for optimum performance?]

### Work room arrangement

### Workplace safety

Consider (as example): https://ors.od.nih.gov/sr/dohs/Documents/Computer%20Workstation%20Ergonomics%20Self%20Assessment%20Checklist.pdf

# Quality/performance metrics

[focus on the human elements]

Connecting to the ‘what can we do’ section.

To measure the quality of VTS organization and work process, several quality, performance and other metrics can be used.

### Errors

While it is not possible to eliminate all the errors fully, these metrics help to estimate the error rate during routine and critical operations of VTS:

1. Errors made by operators per period in general
2. Errors for specific types of operational scenarios
3. Errors by severity
4. Errors by cause (unproper training, stress and fatigue, poor usability, etc.)

These metrics are used to identify the crucial parts of the system and factors to be reviewed. Also they can help to estimate the general progress of human factors approach.

### Cognitive load

Cognitive load metrics help to identify the issues with excessive load of the operator during daily procedures, that can cause stress, fatigue with ongoing efficiency decrease and increasing amount of human errors.

#### Interpretations

This aspect is used to determine the amount of cognitive (internal) efforts to understand the information provided by VTS technical sources. For example, if timestamps of alerts are presented to the operator, he has to interpret by his own how old are they compared to current time. Or if targets speeds and courses are provided, how high the risk of collision is.

By measuring the amount of data occurrences and their probable interpretations, what time it takes to interpret, and which additional information sources (like current time in example above) are need to close the “perception -> interpretation -> decision making -> action” loop, we can estimate the overall cognitive efforts and identify areas for optimisation of interaction between stakeholders, including VTS operators, vessel personnel, and VTS systems.

There is always a risk of too narrow predefined interpretations.

#### Clutter (signal/noise ratio)

There is a need to find the proper balance between amount of information provided to the VTS operators and its relevance to current situational context and tasks. Excessive and useless information can distract operator from more critical one, and lead to the ignorance of relevant messages and loss of situation awareness. But too filtered information can also lead to the same results. (Problem known from the Boy who cried wolfes fable).

Example: “Loss of target” alert, that triggers every time the radar loses the acquired target. But we can result with MV Cemfjord case, when the loss of the vessel was not identified.

During test sessions, the events of information updates (both visual and audible, including VHF contacts, visual indications, sound alerts, VTS notifications, etc.) and responses to them can be measured, classified by type, source, severity, etc., and the relevance and usefulness can be estimated., and the final signal/noise ratio counted.

[general aspect – when addressing multiple inputs of information – information overload, also removing unnecessary information. Addressing how information is ‘brought in’ to the VTSO – visual, auditory.

### Speed of usage

One of the simplest and most important metrics, that helps to measure how many actions and for how long it takes to perform certain operational scenarios, from the beginning to the end, including time for perception, actions to find and reach necessary information at VTS workstations, interpretation and decision making.

In general, the less is the best, but It is crucial to estimate the risks of awareness loss.

The most popular methods to measure usage speed are Critical path analysis and GOMS [11, 12]

Specific technical methods to minimize, for instance, time to access information or trigger commands can be considered, like the usage of multiple displays, dedicated hardware controls for frequent actions.

[how many actions are necessary to access the information required?

Multiple displays, several workstations, ‘GOMS’ to measure efficiency / amount of actions needed.

### Learning curve

The learning curve metrics are used to estimate how it is easy to start and continue using basic and advanced procedures of VTS:

* Affordance rate: How many procedures are completed before training, after training and after some period of system usage (or extra trainings)
* Experience rate: The ratio between time required to complete the specified task at the first time right after the training, and the time for the same task after some period of system usage — helps how the system supports experienced users and forming of strong habits
* Decay rate: How many tasks from the training are able to be completed without errors after some period.

### Emotional response

Emotional response highlights the general satisfaction with work environment and tools provided. This is identified by general anonymous questionnaires provided to VTS operators, with closed and open questions like:

* How are you satisfied with the workroom conditions (workstations, design of the interior, etc.)?
* How often you feel negative emotions (including rage) to the system you are working with?
* If you had negative emotions on your workplace recently, please describe them and their cause

The higher (or at less less negative) response is observed, the better is.

Additional attention can be added to the aesthetical factor, because there are signs, that the systems, perceived by operators as “ugly” or “too fancy” can lead to the drop of usage efficiency.

[sense of ‘satisfaction’ with work environment; impact of positive and negative emotional response; addressing emotional ‘noise’; esthetical environment and efficiency of operations]

# What can we do and how

To make human-machine system of VTS more stable and less prone to issues errors in terms of human factors, the systematic work with human factors is necessary:

* Identification and elaboration of current risks in existing technical, organizational, human related factors
* All changes and additions to VTS system to be estimated in terms of human factors risks/improvements with according ongoing responses and changes.
* Feedback channel to be organized across the VTS organization and 3rd parties, that interact with VTS. Informing about this opportunities and activities.
* Active procedures for interviews and research of human factors

All these activities are to be done during the whole lifecycle of VTS, including planning, installation, and operation.

[this section to present options to address the aspects of Human Factors and Ergonomics.

## Requirements/recommendations

### Environmental (lightness, noise, temperature, air, etc.)

[best environment for work, reduce fatigue and stress inducers]

* Avoiding direct sunlight, and glares from artificial light on shared wall-mounted and workstation displays.
* Minimisation of ambient and equipment sound noise, usage of sound absorption materials, panels and carpets to minimize reverberations.
* The organization of workplaces and its partitioning to avoid audio distractions from neighbor operators
* Minimisation of visual noise (calm interior colours with low contrast, minimalist furniture, proper movement ways organisation to avoid peripherial vision distractions by someone walking from one place to another, etc.)
* Rest rooms organization
* Optimal temperature range, proper ventilation and air conditioning
* Regular measurements of noise, lightness and temperature, air quality (CO2)

### Operator-related

[may not be required here – confirm the location in G1156; Recruitment of VTS personnel]

### Workspaces, including anthropometric aspects

(vision field, available space, priorities of tools accommodation on the desk)

Images and examples to be added.

* Shared access displays (videowalls) usage to support situation and operational context sharing
* Proper methods to organise the workstation layouts depending on the priorities of the tools and information provided
* Recommended set up (static chart displays for situational awareness, dynamic screens for contextual tasks)
* Mouse / trackball usage for multiple screens
* Possibility to be provided to work both when the operator seats in the armchair and when he or she stands — it helps to decrease the fatigue and keep the concentration.

### User interfaces and physical controls

#### Day/night modes

It is recommended to support comfortable day and night watch conditions, including:

* Changes in light conditions in the VTS centre control room
* Customisation of user interface colour theme that supports day, dusk and night light conditions
* Avoiding blue light sources for night mode, red is recommended for night vision (check IEC 62288)

#### Multimodal support

(visual, audio, haptic?)

* Critical alerts are to be duplicated by sound signals, because they could be ignored when the operator is not observing the displays. The signals should be clear and definitive [14], not too loud but differ from ambient noise.
* The practice of duplication of alerts by using dedicated wall mounted signal panels can be considered, to cross-check that the situation is not ignored by multiple operators or head of the watch.
* The identification of primary controls should be available without direct observation. Groups of controls to differ by form and material texture to avoid confusion

#### Physical vs digital controls

Frequent operations, like alerts acknowledgment or primary tools activation (i.e. EBL/VRM, Rendezvous points, VHF communications) are recommended to be done with hardware (physical) controls on dedicated keyboards or control surfaces, available near at hand.

### Situational awareness support

# DEFINITIONS

The definitions of terms used in this Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) at <http://www.iala-aism.org/wiki/dictionary> and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

# ACRONYMS

GOMS — “Goals, Operators, Methods, Selection rules”

HMI — Human Machine Interface

UI — User Interface

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16. Appendix: Examples of key risky situations in terms of HF
    1. Change of the watch
    2. Normal/crisis mode
    3. Alerts management
    4. Communication
    5. Interruptions

Take ideas from:

<https://www.faa.gov/aircraft/air_cert/design_approvals/human_factors/media/OUFPMS_Report.pdf>

<https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/3291/Reports2011-2013.pdf>

<https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1843_Web.pdf>

Additional thoughts after discussion

* Consider training aspect
* Review incidents and HF role in them
* + Technical level (another level)