User interaction
In accordance with ergonomic standards
Response speed sufficient for interaction without disrupting task
Comfortable for long watches
Operator interface permits monitoring, control/supervision of machinery/equipment
Visual/audible/mechanical feedback acknowledges operator input
Functions requested by operator confirmed by displays on completion

Visual clarity
Information clear
Display formats free from irrelevant information
Logical grouping & structure of information
Display formats not densely packed/cluttered
No distraction from user’s primary tasks

Consistency
Information consistently presented within & between sub-systems
No confusion/errors through inconsistencies
Graphical symbols and colour coding in accordance with recognised International Standard
Symbols used in mimic diagrams consistent across all displays
Screen layout & arrangement of information consistent
Flashing of information reserved for unacknowledged alerts or transient states

Compatibility with users’ expectations
Information/labelling in accordance with recognised standards/conventions
Information in form that users are accustomed to
Control functions work as users expect
Equipment mode obvious to user

Alarms
Provision of alarms consistent with Human Hazard Assessment
No unnecessary alarms
Alarm philosophy based on good practice
Accepting/cancelling alarms do not cause distraction/excessive workload
Alarms prioritised/grouped to reflect urgency
Captions/alarm list messages easily understood
Different audibles easy to distinguish
Sufficient alerting when user busy with other item of equipment

Error prevention and correction
Failure indications clear & unambiguous
Sufficient information to identify cause of failure
Assistance in recovering from user error
‘Undo’ function provided
Single user errors identified and avoidable
Operator confirmation provided for control action that could affect safety of ship
**Flexibility and control**  
Equipment meets needs of different users  
User ‘in control’ of sequence of commands/actions  
Able to switch between tasks with some incomplete  
Obvious to team who is in control of particular function(s)  
Transfer of control compatible with good watchkeeping procedures

**Situation awareness**  
Functional overview display provided  
Equipment & arrangements assist operator in maintaining awareness of overall situation  
Operator not absorbed in what equipment is doing  
‘Head-down mode’ avoided

**Automation and status indication**  
Operating mode of machinery & equipment clearly indicated  
Defects/failures & their implications obvious to user  
Able to override automation or intervene part way through process  
No monotonous monitoring tasks  
Procedures & assigned tasks address failure modes

**Support for operator tasks**  
User interaction in accordance with task requirements  
Needs of all watch conditions & situations considered  
Specific needs of particular users considered  
Workstation design supports teamworking & assignment of tasks  
Operator able to crosscheck control actions

**Supporting tasks**  
Adequate storage of manuals, log books, work surfaces, etc  
Able to perform background tasks at workstation  
Background or supporting tasks do not cause distraction or additional workload

**Panel layout**  
Panel layout logical  
Items grouped & sequenced in manner that supports correct use & helps to prevent errors  
Controls & displays positioned according to frequency, urgency and criticality  
Controls & displays grouped according to sequence of use  
Keyboards divided logically into functional areas

**Controls, displays & labelling**  
Controls, displays & labelling clear & easy to access  
Purpose of each control clearly indicated  
Controls and indicators easily distinguishable  
Where control is provided by touch screens, soft keys are of a sufficient size for operation in areas where vibration occurs or gloves are likely to be worn  
Where virtual keypads/keyboards or dialogue boxes are used on touch screens, they do not obscure status or alarm areas of the display  
Functions supported by display clearly indicated
Indications provided by instrumentation which are displayed digitally do not change more frequently than twice per second

Fixed circular scale pointer moves clockwise to indicate increasing value in single direction
If pointer fixed, scale moves anticlockwise to indicate increase in value
Horizontal linear scale pointer moves left to right to indicate increasing value
Vertical linear scale pointer moves upwards to indicate increase in value
Pointer does not obscure numbers on scale
Graphical information readable from relevant operator positions under acceptable lighting conditions
Character height in millimetres not less than 3½ times reading distance in metres
Character width 0.7 times character height
Sans-serif character font used in displays
Lower case letters used in descriptive text
Information related to safe operation of machinery & equipment continuously available to Operator
Failure indications clear & unambiguous
Sufficient information to identify cause of failure
Display visibility satisfactory in conditions of daylight, darkness or no natural light
Appropriate signage for control room & items in it

**Documentation design**
Appropriate formats of documentation provided
Documentation consistent with equipment
Documentation provided in correct language
Documentation easy to use
Documentation does not cause distraction from safe and effective watchkeeping
Needs of all watch conditions and situations considered
Specific needs of particular users considered

**Environment**
Control room environment meets criteria for heating, ventilation, air conditioning, airflow, humidity, heat sources; noise; vibration; ship movement
Control stations positioned as far away from, or insulated against, sources of structurally transmitted noise
Heating, ventilation & air conditioning systems maintain temperature between 18°C and 27°C
Airflow from heating/air conditioning systems not guided directly to operator
Lighting sufficient to avoid glare/reflections from working & display surfaces, flicker-free
Non-reflective or matt finish on surfaces
Placement of controls, displays and indicators consider position of light sources relative to operator, with respect to reflections & evenness of lighting
Transparent cover fitted over a control, display or indicator designed to minimise reflections
Level of lighting sufficient to enable operation of user interfaces
Chairs provided at control stations adjustable to allow for varying heights of operators
Physical hazards, e.g., sharp edges, protuberances and trip hazards avoided
Sufficient handrails fitted to enable operators to move and stand safely in rough seas
Easy to clean work surfaces capable of withstanding oils and solvents common to ships

**Field of view**
External view meets Regulatory requirements
Satisfactory horizontal field of view from each workstation

3 of 6
Satisfactory vertical field of view over bow from conning & manoeuvring positions
Window inclination, dimensions, framing & heights of upper & lower edges satisfactory
Satisfactory view between different workstations/operators

### Room layout
- Layout supports operation in all watch conditions & emergency situations
- Location of equipment appropriate to operator task does not cause distraction to other users
- Sufficient space & access for intended number of operators in expected operating conditions
- Local control stations positioned to minimise risk of harm to operator
- Instruments face operator’s intended working position

### Access
- Access to & within control room meet ergonomic criteria
- Controls easily accessible to operator at workstation
- Layout of control room meets ergonomic criteria
- Ease of maintenance addressed
- Ease of cleaning addressed

### Occupational safety
- Measures for occupational safety, including grab rails, non-slip surfaces, warning signs, protective clothing, protuberances, safety equipment marking, escape & survivability, security, cleaning

### Training the Team
- Crew training considered in the design
- Training provision aligns with assumptions provided by equipment manufacturers
- All types of task included in the operational situation defined
- Risks, penalties & performance goals for process & operator behaviour emphasised
- Training in recovery procedures included
- Operating teams trained together in allocation and/or transfer of responsibility
- Operating teams trained together in transfer of information
- Frequent refresher training provided for infrequently used skills & knowledge
- Performance standards & enabling objectives set
- Criteria for fitness for duty of watchkeepers set
- Proposed training feasible in context of watchlists/duty patterns/conditions of employment
- Training compatible with operation of ship

### Manning
- Weather conditions, visibility, daylight/darkness considered
- Workload on watchkeepers considered
- Trade pattern & activities taking place on board the ship at any particular time considered
- Culture, nationality & language of watchkeepers considered
- Fatigue, meals & rest breaks considered
- Management /supervision considered
- Critical control spaces never left unattended
- Fall back or reversionary modes as part of system dependability & required manning in such modes considered
- Career progression considered
- Hours of work/rest taken into account
Safety management considered
Training and certification considered

Procedures
Procedures prevent single person error
Procedures support cross-checking and supervision
Procedures make provision for feedback
Procedures make provision for confirming that orders have been complied with
Procedures align with training & certification of personnel
Procedures provide clear assignment of responsibilities
Procedures do not introduce unnecessary workload
Procedures do not introduce distractions
Required responses consistent & compatible with user expectations
Procedures compatible with established conventions for terminology
Procedures match the specific equipment fitted
Procedures address the needs of failure and fallback mode
Procedures cover all operational states indicated by the equipment
All operational states indicated by the equipment & all alarms addressed by procedures
Information to be communicated by procedures unambiguously available when required
No easier, more dangerous alternatives
Procedures cover all watch conditions and situations

(Adapted from Lloyd’s Register Rules and Regulations for the Classification of Ships, Part 6, Chapter 1 Control Engineering Systems, Section 3 Ergonomics of control stations; and the ATOMOS IV SOLAS Regulation V/15 Template 2013 Retrofit and Newbuild)

Useful documents
1. SOLAS Regulation V/15 submission template for major refits and newbuilds
   www.he-alert.org/filemanager/root/site_assets/standalone_articles_not_linked_to_a_bulletin/HE00085.pdf
2. Lloyd's Register Rules and Regulations for the Classification of Ships, Part 6, Chapter 1 Control Engineering Systems, Section 3 Ergonomics of control stations
3. The High Performance HMI Handbook
   www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=38009
5. ISO 11064 Series - Ergonomic design of control centres
   www.iso.org/iso/home/search.htm?qt=11064&sort=rel&type=simple&published=on
6. IMO MSC/Circ.83 Guidelines for engine-room layout, design and arrangements
   www.imo.org/blast/blastDataHelper.asp?data_id=8819
7. IMO Resolution MSC.337(91) Adoption of the code on noise levels on board ships

8. IMO Resolution A.1021(26) Code on alerts and indicators, 2009

9. IMO MSC/Circ.982 Guidelines on ergonomic criteria for bridge equipment and layout

10. IMO SN.1/Circ.265 Guidelines on the application of SOLA Regulation V/15 to INS, IBS and bridge design

11. IMO SN.1/Circ.288 Guidelines for bridge equipment and systems, their arrangement and integration (BES)