

CHIRP

Marine Operating &
Maintenance Manuals-
Are They Good Enough?

Introduction

Safety is in the interest of all those participating in any maritime activity.

The objective of *CHIRP* is to promote safety in the maritime sector for employees and others by receiving, distributing and analysing safety related reports which would not otherwise be available; whilst at all times keeping the identity of the reporter confidential.

CHIRP is an independent confidential reporting programme for people employed or having an active interest in the maritime industry. CHIRP's primary purpose is to represent safety related issues to the relevant organisation(s) without revealing the identity of the reporter. CHIRP is not intended to be a "whistle blowing" programme.

CHIRP has its origins in the UK civil aviation industry and has been in existence there since 1982. It has been introduced as a new safety element to the maritime sector as an innovative way of promoting the improvement of its safety culture.

CHIRP for the maritime industry is funded by the UK Department for Transport. The independent charitable status of CHIRP ensures its impartiality in dealing with all reports received; no matter which organisation may become involved in subsequently remedying any reported problems.

A Board of Trustees, ultimately responsible for CHIRP, is supported by a Maritime Advisory Board drawn from professionals in the industry. It is formed to provide specialist advice and feedback to the Trustees on the performance of the Programme. This Board meets quarterly to consider disidentified reports received and give advice to the Director (Maritime) on possible courses of action to be taken in particular cases.

The current Maritime Advisory Board Members and the terms and conditions under which ***CHIRP*** operates may be viewed at www.chirp.co.uk.

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CHIRP

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Executive Summary

This paper results from a concern reported to CHIRP by a seafarer and the subsequent discussions, investigation, and correspondence on the subject. Whilst a significant amount of research has been undertaken, it is not suggested that the treatment of the topic is exhaustive. It is believed the analysis which follows will permit those with an interest and/or responsibility for the issues outlined to progress and, where necessary, resolve any satisfactorily verified areas of concern.

The concern was reported in the following terms:

Report Text: “.....The style and presentation of engine operation & maintenance manuals should be subject to review and a set of minimum standards agreed and imposed by the relevant classification societies. Too often engine manufacturers adhere to their own ways, which are not always clear and unambiguous. This could lead to confusion, error and ultimately could compromise the safety of the vessel and crew.

In view of the very high capital cost of marine engines, it is reasonable to expect a set of manuals that cover the “as fitted” installation. This is rather than some generic publication that attempts to include many engine variants and applications [marine and non-marine]. It has to be said that some manufacturers seem to be guiltier in this respect than others.

In some cases, the manuals provided are not originals, i.e. they are photocopies sometimes of dubious quality. As a lot of photographs are provided in place of engineering drawings it is often difficult to make out sufficient detail.

In these days of inexpensive desk-top publishing, manufacturers could easily arrange for a bespoke publication to be printed and presented from its database.”

Whilst the concern raised was of a general nature it was believed suitable for presentation to the CHIRP Maritime Advisory Board because it indicated a potential safety related latent defect in the underlying processes supporting the seafarer.

The questions this report seeks to address in some measure are:

1. To what extent does the current standard of operating and maintenance manuals contribute, or have the potential to contribute, to accidents and incidents on ships?
2. To what extent do current requirements impact on this area, positively or negatively?
3. What, in the opinion of the CHIRP Maritime Advisory Board, are the appropriate conclusions and recommendations?

In order to answer these questions the CHIRP Maritime Advisory Board drew on the experience of its own Members, canvassed industry opinion through its publication CHIRP FEEDBACK, sought the views of the Members of The Institute of Marine Engineering, Science and Technology (IMarEST) via their journal Marine Engineering Review (MER), queried the UK national accident/incident database held by the Marine Accident Investigation Branch (MAIB) and reviewed relevant regulations and guidance.

Conclusions

The reported incident combined with the evidence gathered through raising the issue in CHIRP FEEDBACK, MER and other sources, including the collective experience of the Board, endorses the reported concern.

From the discussion of the issues outlined above the Maritime Advisory Board suggests the main conclusions are:

1. Seafarers are expected to assimilate different equipment fits quickly and perform to high operational standards.

2. Seafarers are expected to be able to move from ship type to ship type with few restrictions; this flexibility is considered essential for the efficient management of human resources.
3. Seafarers are likely to encounter equipment fits on which they have not been specifically trained.
4. Strict equipment type controls could promote consistency across the world fleet, but may tend to restrict suppliers and innovation.
5. Strict “type rating” of personnel could assist seafarers in meeting the requirement to join ships and perform to high operational standards quickly, but this may tend to restrict the flexibility of the workforce.
6. Access to a wide and competitive marketplace for equipment is considered essential operational and commercial reasons.
7. It is widely recognised the standard of manuals provided to seafarers varies greatly in terms of specificity, content, language and presentation and is often poor, leading to an increased risk of human error. The drivers in manual production are not necessarily the needs of the end user, but may be “defensive engineering and liability practices¹”.
8. The absence of a system for document control for manuals provided by the manufacturer means the manufacturer loses the opportunity to notify the owner of relevant updates and product developments and therefore such manuals as are provided are likely to be out of date after a relatively short period.
9. Manuals are not necessarily supplied in a language in which the crew are proficient and this, coupled with the quality issues outlined must represent a significant increase in the risk of errors being made either by failing to interpret the manual correctly or failing to refer to it at all.
10. Integrated systems pose particular challenges with respect to the provision of effective operating and maintenance manuals and those challenges are not always met.
11. The failure to supply good quality technical/operating manuals or supplying manuals which are hard to understand and/or inadequate operating instructions has contributed to a number of marine accidents.
12. A logical consequence of the failings listed in item 11 is personnel being unfamiliar with equipment and/or not trained in its use and these factors have also contributed to a number of marine accidents.
13. Other safety critical industries and transport modes have recognised the importance of technical/operational documentation and established controls to ensure adequate and consistent standards.
14. The IMO, whilst it has recognised the importance of establishing controls to ensure technical/operational documentation is of an adequate and consistent standard in limited applications, has not applied these principles more generally.
15. Whilst the relevant recommendations and guidance are available, there appears to be a stark contrast between what is recommended and what actually appears in the workplace.
16. Whilst Port State Control authorities have powers to audit this area, their effectiveness is constrained by the absence of an auditable standard.
17. Equipment manufacturers do not generally differentiate their products in the market place on the quality of their manuals and, in this sense; manuals should not represent a significant commercial issue.

¹ See page 12

18. The absence of an agreed standard means good quality documentation is a “cost option” invested in by a discreet sector of the ship owning/operating community, when it should be provided to all.
19. The adoption of standards for technical/operational documentation offer the potential to provide an element of consistency through a diverse equipment/personnel environment, reducing the risk of human error and promoting operational integrity and consistency.

Recommendations

Following these conclusions the Maritime Advisory Board makes the following recommendations:

1. Manufacturers of equipment for safety critical marine applications across life saving, cargo operating, navigation, communications and engineering disciplines should provide operating and maintenance manuals to a common document standard “using a uniform layout as well as agreed terms, abbreviations and symbols for the correct use of such manuals by mariners.²”
2. The use of simplified technical vocabularies and icons should be encouraged. If used, reproductions of photographs and drawings should be of an adequate standard and documents should be available in an agreed number of languages.
3. A relevant authority should verify the compliance/standard of documentation at the design/approval/acceptance stage and audit its continued compliance thereafter.
4. Documents produced to the standard should be controlled and include notifications to manufacturers to accommodate through life operational changes e.g. a change of ownership, crew nationality, etc.
5. Where integrated systems are fitted, a manual covering the entire system should be available. Particular attention should be paid to Failure Mode Effect Analysis for such systems.
6. Training regimes should be amended where necessary to ensure familiarity with the use of manuals produced to the standard. Thereafter, provided the seafarer continues to encounter manuals produced to the standard, efficient familiarisation and operation should be promoted.

² See page 19

CHIRP reports are published only with the agreement of the reporter and are, as far as possible, in their own words, edited only to remove identifying text. The safety concern(s) raised are based on the information provided by the reporter and therefore represent the reporter's perspective.

The Report

Report Text: “The style and presentation of engine operation & maintenance manuals should be subject to review and a set of minimum standards agreed and imposed by the relevant classification societies.

Too often engine manufacturers adhere to their own ways, which are not always clear and unambiguous. This could lead to confusion, error and ultimately could compromise the safety of the vessel and crew.

In view of the very high capital cost of marine engines, it is reasonable to expect a set of manuals that cover the “as fitted” installation. This is rather than some generic publication that attempts to include many engine variants and applications, [marine and non-marine]. It has to be said that some manufacturers seem to be guiltier in this respect than others.

In some cases, the manuals provided are not originals, i.e. they are photocopies sometimes of dubious quality. As a lot of photographs are provided in place of engineering drawings it is often difficult to make out sufficient detail.

In these days of inexpensive desk-top publishing, manufacturers could easily arrange for a bespoke publication to be printed and presented from its database.”

Whilst the concern raised was of a general nature it was believed suitable for presentation to the CHIRP Maritime Advisory Board because it indicated a potential safety related latent defect in the underlying processes supporting the seafarer.

Maritime Advisory Board Discussions

The Maritime Advisory Board first considered this topic at its meeting on 24 September 2003 and has reviewed and commented upon various inputs received by CHIRP subsequently.

At the first meeting, by way of background, the CHIRP Deputy Director (Engineering) (Air Transport) described the requirements for the layout of manuals in the aviation industry and how the machinery certification process includes the manuals which are produced in a standard form. Aviation personnel are also strictly “type rated” and controls are established limiting the type of equipment individuals may operate and maintain and also the range of tasks they are permitted to perform. The effect of this requirement is that engineering staff, irrespective of the aircraft involved, are able to find relevant information quickly and accurately and conversion training is facilitated. Simulation takes place on equipment which is “as fitted/flown”. Transfer between aircraft types involves conversion training and reassessment/recertification.

In the Board's experience the poor standard of many manuals was endemic and there was significant potential for confusion and error. The concern was also applicable to other equipment areas, including lifesaving, communications, cargo handling and navigation, partly because of a tendency on the owners' part to pay insufficient attention to the specification of the manual when ordering and partly owing to an absence of formal requirements. An aviation style solution might be considered desirable.

The Board noted that the specification for military vessels invariably included a standard documentation format and that simplified English, icon driven documents had been developed for certain applications.

The situation in aviation and defence was compared with that outlined in the report pertaining to the civil maritime sector, where, with some exceptions e.g. dangerous cargo endorsements, seafarers are

generally not “type rated” and are expected to be able to transfer from ship to ship freely and rapidly familiarise themselves with a wide variety of equipment types. Seafarers may have been trained on equipment in simulators that they do not encounter at sea, but are nevertheless expected to operate/maintain to a high standard. These activities are not generally supported by standard document formats.

It is clear that strict “type rating” of individuals could reduce the risk of errors by preventing individuals from undertaking tasks on equipment with which they were unfamiliar. However, the Board considered the flexibility of the maritime work force to be essential and whilst acknowledging there was scope to “type rate” certain activities further e.g. cargo endorsements; overly restrictive requirements could be undesirable.

Restricting the equipment fits on ships could also potentially address concerns arising from unfamiliarity, but the Board considered a competitive and innovative equipment marketplace to be desirable and therefore regulations which might overly restrict market participation and innovation would be resisted.

The Board considered that standard document formats had the potential to introduce an element of consistency through a diverse equipment/personnel environment, reducing the risk of human error and promoting operational integrity and consistency. The Board also observed equipment manufacturers do not generally differentiate their products in the market place on the quality of their manuals and, in this sense; the introduction of standards should not represent a significant commercial issue.

Initial Actions

After the Board’s initial discussions options were summarised as one or more of the following:

1. Publishing the report and take additional steps to seek a better understanding of the concern and how widely it is recognised.
2. Writing to a number of engine manufacturing associations and the manufacturer concerned to establish their views
3. Raising the issue with the International Association of Classification Societies (IACS).

It was agreed to publish the report and highlight the generic issues it raised in order to obtain further information validating the concern and to write to both the manufacturer and IACS, raising the issue and seeking their comment.

Subsequent Actions

The report was published in the first edition of CHIRP’s Maritime FEEDBACK in autumn 2003 with the following comment, agreed by the Advisory Board:

CHIRP would like to hear more on this subject before pursuing it further. It is believed that this problem may be more widespread. There are ISM Code issues related to the requirements for "valid" documents (s.11) and maintenance systems (s.10).

The International Association of Classification Societies has produced guidance on manuals. Are owners specifying compliant manuals when ordering equipment?

In the aviation industry manuals are part of the approval process leading to certification and are produced to a standard.

Would something similar help here?

Letters were written to the Chief Executive of the manufacturer concerned, to a number of manufacturing associations and to the International Association of Classification Societies (IACS).

The manufacturer did not acknowledge the correspondence, however two engine manufacturing associations and IACS responded positively to the issue; the latter discussing the concern at its

General Policy Group meeting in March 2004. A presentation was made to the Marine Seagoing Engines Working Group of The European Association of Internal Combustion Engine Manufacturers (EUROMOT) in October 2004.

An open letter was also written to the Members of The Institute of Marine Engineering, Science and Technology (IMarEST) via their journal Marine Engineering Review (MER) asking the following questions:

- “1. Do you agree that the current situation with respect to operating & maintenance manuals is unsatisfactory and could pose the risks outlined above?**
- 2. Should operating & maintenance manuals be produced to a standard format, irrespective of manufacturer and would this assist in training and reducing the possibility of maintenance errors?**
- 3. Should operating & maintenance manuals be included in the machinery certification process?**
- 4. Should operating & maintenance manuals be track changed with a corresponding facility to notify the manufacturer of change of vessel ownership?**
- 5. How should language requirements be accommodated bearing in mind potential changes of ownership and/or crew and the possible need to audit currency?**
- 6. What equipment should be covered by any new requirements?”**

CHIRP has continued to receive correspondence on the subject of this report and has periodically updated readers of CHIRP FEEDBACK on how the issue has been progressing.

A search of the national database for relevant cases was requested from the UK Marine Accident Investigation Branch (MAIB).

A document review was conducted to establish the existence of relevant regulation/guidance using the International Maritime Organisation’s Vega Database and documents available on the IACS website (www.iacs.org.uk).

These activities have resulted in the decision to produce this thematic report for industry to consider.

Discussion

For ease of consideration the report has been broken down in to a number of discreet areas. CHIRP has made enquiries and conducted preliminary research, with a view to validating the concern and identifying possible areas of interest, which may lead to resolution and prevention of recurrence.

1. The Incident

Report Text: “In view of the very high capital cost of marine engines, it is reasonable to expect a set of manuals that cover the “as fitted” installation. This is rather than some generic publication that attempts to include many engine variants and applications, [marine and non-marine]. It has to be said that some manufacturers seem to be guiltier in this respect than others. In some cases, the manuals provided are not originals, i.e. they are photocopies sometimes of dubious quality. As a lot of photographs are provided in place of engineering drawings it is often difficult to make out sufficient detail. This could lead to confusion, error and ultimately could compromise the safety of the vessel and crew.”

CHIRP Comment: In an attempt to try and establish the extent to which the reported issue contributes to accidents at sea the MAIB were approached and requested to conduct a database search for incidents involving manuals, written procedures and/or instructions, particularly where produced by the manufacturer. The MAIB were also requested to identify incidents in which “unfamiliarity” featured, as this was considered to be a logical consequence of a failure to provide appropriate guidance. The searches cover the period 1990 to date and duplicates were eliminated.

Operating manuals not supplied or hard to understand	22 incidents
Operating instructions inadequate	22 incidents
Equipment badly maintained	1 incident
<u>Total</u>	<u>45 incidents</u>

Of which:

Accidents to person	20 incidents
Machinery failures	14 incidents
Groundings	4 incidents
Hazardous incident	3 incidents
Fire/Explosion	2 incidents
Capsize/listing	1 incident
Escape of harmful substance	1 incident

Personnel unfamiliar with equipment / not trained in use 66 incidents

Of which

Machinery failures	18 incidents
Accidents to person	15 incidents
Groundings	10 incidents
Flooding	7 incidents
Collisions	5 incidents
Fire/Explosion	5 incidents
Contacts	4 incidents
Capsize/listing	2 incidents

In reviewing the results it should be borne in mind the MAIB’s remit extends to incidents reported involving UK flag vessels internationally and incidents involving vessels of any flag in UK waters. The extent to which these figures may be extrapolated is not discussed in this report, but the

relative size and quality of the sample may provide some indication as to the extent the reported concern impacts the world fleet.

More detailed research into the incidents provided by the MAIB would be required to gain a fuller understanding of the specific contribution the reported concern made in each event, however given the absence of representative accident/incident data subjected to investigation to a consistent standard from the industry as a whole and the generality of this discussion, it was not considered necessary for CHIRP to conduct this additional exercise to draw appropriate conclusions.

It may be concluded from the forgoing that the failure to supply good quality technical/operating manuals or supplying manuals which are hard to understand and/or inadequate operating instructions has contributed to a number of marine accidents. A logical consequence of these failings is personnel being unfamiliar with equipment and/or not trained in its use and these factors have also contributed to a number of marine accidents.

From the information CHIRP has been provided it is clear the reported concern has contributed to accidents. In advancing this opinion the Maritime Advisory Board acknowledges the incidents are not necessarily solely attributable to the factors described in the report text, but the concern and the consequences described undoubtedly feature to a greater or lesser extent.

2. The Cause

Report Text: “Too often engine manufacturers adhere to their own ways, which are not always clear and unambiguous. This could lead to confusion, error and ultimately could compromise the safety of the vessel and crew.”

CHIRP Comment: Acknowledging the findings of the previous section, CHIRP turned to the responses received after raising the issue in its publication CHIRP FEEDBACK and MER.

The canvassing of opinions in this way drew a considerable number of responses, providing views from a number of different perspectives. Edited extracts from the responses received are reproduced below.

This first response comes from an organisation working within the insurance surveying community:

“On the subject of maintenance manuals, you have hit on a sore point which nobody appears to pay any attention to. During our risk assessment surveys, three things commonly come to our notice which we require to be put right:

1. There is no "Proper" maintenance manual as such, and very often, engine manufacturers provide an operation/maintenance manual and a spare part manual, but the information contained in these manuals is not really sufficient to ensure the maintenance is carried out correctly.
2. The manuals are most often supplied in the English language yet the officers and crew might not understand it. Even on new ships, the documentation will not have been supplied in the language of the owner and crew. Some engine manufacturers are particularly poor at this, and assume that everybody speaks English. At least one does not provide manuals in any other languages as far as I know, despite our pressure on owners to press them into providing such.
3. Service bulletins and technical service letters are not reaching the consumer. Engine manufacturers are notoriously poor at distributing this kind of information. Ship owners also overlook the need to request such documentation. It can contain very valuable advice.”

However, not all shared this view;

"I believe that targeting manufactures for fault re: operating and maintenance manuals is not correct. As a marine equipment supplier, we typically provide numerous printer-original copies of operating manuals with our equipment. We see the shipyards (our prime customer), the owner, the owners technical representative, the charter company (if applicable), the port engineer, and others take copies of the manuals for their legitimate purposes. The crew is left with one, which the chief engineer may hoard.

Just a couple of observations:

Our manuals are supplied in both hard copy and electronic (CD) form. This is typical, in our experience, of what other marine equipment manufactures provide.

It takes a couple of hours to assemble a manual. So the fully burdened cost of producing and shipping a manual runs around USD 100-200. Shipyards and operators wince when they have to pay for additional manuals. The shipyards kick the crap out of us from a cost standpoint so there is no margin to provide freebies. Sorry, but this is a fact of life in a super-competitive cost environment.

Except for military jobs, we never see a specification referenced for the content of our manuals. Rather, the content of our manuals is driven by defensive engineering and liability practices."

This comment generated the following response from a ship owner's employee:

"The Company are presently constructing their first a vessel. My main activity is to train all personnel ready for when the vessel is delivered and commences a long term charter.

Your article 'Operating and Maintenance Manuals' was of particular interest because, as is normal, all equipment for the new build both major and minor will be delivered with operating and maintenance manuals, what is very disturbing is that they will only be in English, one company has been approached regarding this subject and will not budge, only English. Even when pressed for perhaps at least the major items, including the main engine and safety items they would not budge, not even for the fire detection system.

Other manufacturers were approached individually and most would not change their stance. There was one exception, a manufacturer, who was preparing instructions in the language of the crew and asked us to proof read the manual which we happily did and consequently have the manual for one piece of very important equipment in the language of the future operators.

It is for this reason that I cannot agree with the writer who stated 'I believe that targeting manufacturers for fault re: operating and maintenance manuals is not correct'

If not the manufacturer then who?"

Additionally:

"I am concerned at the report of one writer not agreeing with the manuals being provided in the language of the end user.

Although the European Machinery Directive 98/37/EC on the Safety of Machinery does not apply to –"seagoing vessels and mobile offshore units together with equipment on board such vessels or units,"

The regulations still apply to equipment offered for sale in the EEC either as free standing equipment or equipment designed for incorporation into other machines.

As lots of essentially marine equipment is used "on shore", marine engines for generation plant, winches, etc, this equipment when sold in the EEA, must meet the requirements of applicable EEC Directives. The Machinery Directive 98/37/EC specifically states in the essential health and safety requirements, Annex 1 Clause 1.7.4 that:-

“The instructions must be drawn up in one of the community languages [English, French or German] by the Manufacturer or his authorised representative established in the [EEC] community. On being put into service, all machinery must be accompanied by a translation of the instructions in the language or languages of the country in which the machinery is to be used and by the instructions in the original language. This translation must be done by either the Manufacturer or his authorised representative established in the community or by the person introducing the machinery into the language area in question.

By way of derogation from this requirement the maintenance instructions for use by specialised personnel employed by the manufacturer or his authorised representative established in the community may be drawn up in only one of the community languages understood by those personnel.”

As an engineer working for a Notified Body I would expect the manuals to be in English, French or German. I would further expect that if the workforce speaks a different language or the workforce of the end user is predominately of a different language area : any other community country, Italy, Spain, Holland etc, or for example Turkish workforce in Germany, then the instructions would be translated into that language [Two official languages for Belgium] by the Manufacturer.

This would be required to legally apply the CE mark to any Machinery. Realistically this requirement would be stated on the order for the equipment.

It must be noted that this applies only to equipment sold in the EEC.

A number of individuals and organisations in the business of preparing manuals also responded:

“In the case of nuclear power plant and aircraft (military and civil), there is no doubt that manuals are crucial for maximising efficient and safe working. Accordingly, the provision of manuals is required by law.

My work in preparing high quality deck and engine manuals for the shipping industry often made me wish that such manuals were available on board when I was at sea.

Manuals must be classified as controlled documents. People are permanently employed in the nuclear power and aircraft industries for the sole purpose of updating and re-issuing manuals. These activities are in response to manuals whose contents have been affected by matters such as equipment modifications and changes to operating procedures. This updating and re-issuing is required by law.

In fact all documents pertaining to the efficient and safe running of these industries are kept updated. For example, commercial aircraft are built, flown, operated and maintained totally in accordance with controlled documents. These documents are subjected to a very strict document control system, and this control system is a major contributor to the extremely high degree of aircraft safety and reliability.

Can the shipping industry afford such a rigorous document control system? Does it need it?

In fairness, ships are primitive entities compared to nuclear power plant and aircraft. Moreover, personnel on ships have much more ‘hands on’ control over their charges and, normally, much more time to deal with a critical failure. Nevertheless, a full set of controlled manuals on board a ship would greatly enhance the protection of that ship, her crew, her cargo, and the environment. There is also the fact that the increasing number of crew members whose first language is not English would greatly benefit from the provision of controlled manuals that are written in simple English. For the benefit of aircraft staff whose first language is not English, the aircraft industry produces manuals that are written in simple English. This is achieved with the aid of a publication entitled AECMA* Simplified English - Writing Rules and Dictionary. * AECMA = European Association of Aerospace Industries

[Ed Note: Now known as AeroSpace and Defence Industries Association of Europe (ASD) Simplified Technical English]

I used the word 'primitive' in the sense of equipment sophistication. For example, a container ship engine operating manual I prepared had, in addition to the main engine, 55 sub-systems described, each description provided with illustrations. Many illustrations were complex piping diagrams. The plant items within each sub-system were not sophisticated but the number of sub-systems shows the very large coverage that may be required by ships' manuals.

Manuals must be written and illustrated by qualified technical authors and illustrators, who act entirely independently of the equipment manufacturers.

What authors write, and what illustrators illustrate, is based upon the manufacturers' published data. It is quite wrong, and sometimes very dangerous, for ships' personnel to solely rely upon manufacturers' data. Such data often contains flawed information and instructions, serious omissions, poor syntax causing ambiguities, plus poor illustrations.

A technical author acts as a completely independent technical editor of a manufacturer's publications. The author's completed work, in turn, is editorially edited and approved before the manual's publication.

As may be deduced, manual preparation is very expensive. It is not, perhaps, quite so expensive as a loaded bulk carrier breaking in two during a sea passage due to poor loading that, in turn, was due to the lack of a good quality loading manual.

Manual preparation costs, and the costs of controlling manuals, have been somewhat reduced in recent years by the introduction of user friendly PC word processing programs and CAD (computer aided design) programs.

We now have the ability to produce first class documents. There is no excuse for poor quality documents. Additionally, documents that are PC prepared are easily and quickly updated and re-issued. Documents in this context comprise operating and maintenance manuals, ships' GA (general arrangement) drawings, capacity plans, fire fighting plans, stability data, engine room piping diagrams, check lists, etc.

Additionally:

"In response to the topic of Operating and Maintenance Manuals, I comment as follows:

1 Language of Operating and Maintenance Manuals

- (a) All ships trading world-wide must carry a set of manuals written in English because:
 - It would be almost impossible, and certainly very dangerous, for any ship to trade world-wide without its master and officers having some knowledge of English, spoken and written. In the similar case of the global commercial aviation industry, the use of spoken and written English is mandatory.
 - In addition to seafarers, associated world-wide shore personnel such as salvage masters, surveyors, accident investigators, insurers, repairers and lawyers would greatly benefit from ships' manuals written in English.
 - English is the official language, or second language, for a large proportion of both developed and developing countries. Many of these countries currently provide seafarers for ships of all flags.
 - English is the most widely used language and is adopted by 56 countries. The next most widely used language is French and is adopted by 32 countries. Due to population numbers, Standard Chinese is the most widely used spoken language, but only 3 countries adopt this language.
- (b) If a shipowner requires manuals written in a language other than English, then the shipowner must bear the responsibility for providing a second set of manuals in the language required because:
 - The shipowner, for economic reasons may, from time to time, change the nationality of the users.

- The shipowner, for economic reasons may, from time to time, employ multi-national users.
 - The shipowner, for economic reasons, may sell the ship. In this event, if there is not a set of manuals written in English it may mean the new users could inherit a set of completely unintelligible manuals.
 - Translation of manuals is extremely expensive. If carried out by the equipment supplier it will affect the cost of equipment, particularly if it is first rate equipment. This may cause a shipowner to purchase second rate equipment with the attendant impairment of safety and reliability.
 - It is highly unlikely that translators will be familiar with ship operations, expressions and terms. Therefore translations can lead to serious errors that may endanger safety. Additionally, many minor languages do not possess a comprehensive technical vocabulary.
2. Would standard formats for manuals facilitate training and reduce the potential for errors?
- Undoubtedly yes.
 - Take for example the British Admiralty Sailing Directions (Pilot Books). These can be described as standard format manuals. Their consistent format reduces the potential for errors because the users know exactly where to quickly find the information they require.
 - Further, such information is written and illustrated in a consistent style designed to avoid ambiguities and to provide instructions in a simple, clear and consistent manner.
 - They are also controlled manuals by virtue of continuous updating and the recording of that updating in the manuals. With any manual, this process is critical for the safe operation of ships.
 - Manuals used for training ashore must draw trainees' attention to the critical importance of manual updating.
3. Manuals to be incorporated in the certification process (as in aviation)?
- Undoubtedly yes.
 - As in aviation, they must be in English
 - As in aviation, they must be controlled documents.
 - Ships already carry manuals that are incorporated in the certification process, eg: the Pilot Books mentioned in para. 2 above. Other nautical publications required to be carried by law include the operating and maintenance manuals for navigational aids, e.g.: radar.
 - Taking the engine room as an example it follows that for safely navigating a ship from A to B, an operating manual for the main engine management in all conditions of service would equate to a ship's Pilot Book. As far as I know, the law does not require such a manual.
4. My personal thoughts on the incorporation of manuals in the certification process (as in aviation):
- Operating and maintenance manuals are a major contributor to the safety of the ship, crew, cargo and environment.
 - Manuals written in English provide an excellent language learning tool for seafarers whose first language is not English.

- From personal experience, such seafarers are more than keen to become proficient in English because they know that proficiency in English is the key to a safe and affluent career at sea and also offers a good future ashore.
- Top quality manuals are very expensive to produce and can be even more expensive to control.
- The examination of any manual's contents for certification purposes requires the examiner to be fully conversant with topics covered by the manual and is also very time consuming. Therefore a detailed examination of a ship's whole set of manuals is impractical. Consequently, a large degree of trust must be placed in the provider of each manual. Unfortunately, this can lead to the unscrupulous providing a very poor, if not useless, manual.
- An example is the UK nuclear power plant industry. The UK Nuclear Installations Inspectorate (NII) is the UK Government's certification authority for nuclear power plant. This certification requires the provision of operating and maintenance manuals whose content and updating are rarely checked by the NII. The result is that some manuals are of very poor quality and, over time, some manuals become dangerously outdated.
- In fairness, the NII rely upon a nuclear power plant's staff to vet all manuals and to see that they are kept updated. Unfortunately, and due to the associated expense, this process then becomes a budgetary problem. In other words, it is a typical case where safety often becomes a secondary consideration ... a situation in the shipping industry of which you will be well aware!"

Finally:

“The fault is largely with the process where owners, chasing ever lower ship newbuild prices, do not analyse or budget for lifetime costs. Neither do the yards who seek to maintain margins at the expense of equipment makers while driving newbuild prices down have any interest in the cost of their product beyond the point of delivery. In the absence of an industry standard, It is essential that ship owners clearly write into the newbuild specification the coverage of the equipment manuals, the skill level at which they are required, the requirement for ship-specific manuals, confirmation of as-installed data at commissioning and the language required for the final prints. For operating the ship, makers manuals which often cover a single component are inappropriate; the task requires a whole ship operating manual ship specific and system-orientated and clearly specified in the new build specification.”

CHIRP Comment: The results of this canvassing exercise appear to indicate it is widely recognised the standard of manuals provided to seafarers varies greatly in terms of specificity, content, language and presentation and is often poor, leading to an increased risk of human error. The drivers in manual production are not necessarily the needs of the end user, but may be “defensive engineering and liability practices”.

The absence of a system for document control for manuals provided by the manufacturer means the manufacturer loses the opportunity to notify the owner of relevant updates and product developments and therefore such manuals as are provided are likely to be out of date after a relatively short period.

Manuals are not necessarily supplied in a language in which the crew are proficient and this, coupled with the quality issues outlined must represent a significant increase in the risk of errors being made either by failing to interpret the manual correctly or failing to refer to it at all.

Other safety critical industries and transport modes have recognised the importance of technical/operational documentation and established controls to ensure adequate and consistent standards.

Integrated systems pose particular challenges with respect to the provision of effective operating and maintenance manuals and those challenges are not always met.

The absence of an agreed standard means good quality documentation is a “cost option” invested in by a discreet sector of the ship owning/operating community.

3. The Underlying Process

Report text: “.....it is reasonable to expect a set of manuals that cover the “as fitted” installation. This is rather than some generic publication that attempts to include many engine variants and applications, [marine and non-marine]. It has to be said that some manufacturers seem to be guiltier in this respect than others.

In some cases, the manuals provided are not originals, i.e. they are photocopies sometimes of dubious quality. As a lot of photographs are provided in place of engineering drawings it is often difficult to make out sufficient detail.”

CHIRP Comment: Having looked at the evidence available from the MAIB and the industry canvassing exercise, additional research was undertaken to identify what regulation and/or guidance was applicable to the area of concern.

The research began by looking at the applicable provisions of the International Safety Management (ISM) Code, which state:

“11 DOCUMENTATION

11.1 *The Company should establish and maintain procedures to control all documents and data which are relevant to the SMS.*

11.2 *The Company should ensure that:*

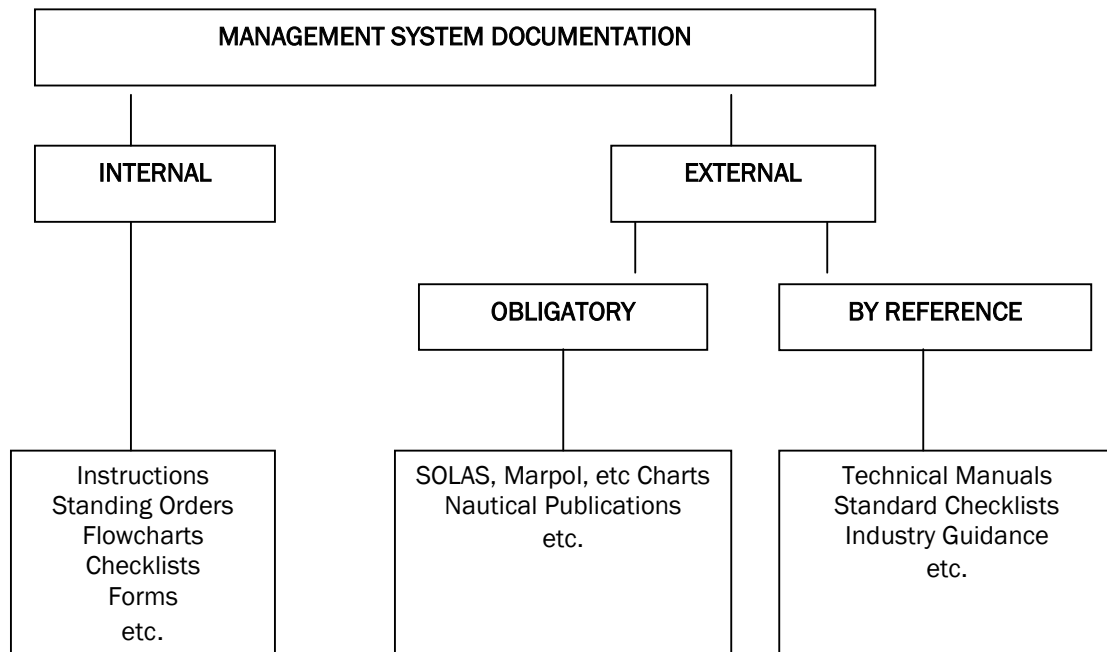
- 1** *valid documents are available at all relevant locations;*
- 2** *changes to documents are reviewed and approved by authorized personnel;*
- and*
- 3** *obsolete documents are promptly removed.*

11.3 *The documents used to describe and implement the SMS may be referred to as the “Safety Management Manual”. Documentation should be kept in a form that the Company considers most effective. Each ship should carry on board all documentation relevant to that ship.*

The International Association of Classification Societies (IACS) in Recommendation 41 – Guidance for IACS Auditors to the ISM Code states for this section:

“....Both internally and externally generated documents must be controlled where necessary. Where the Company has chosen to incorporate external documents into its management system documentation by reference, then those documents must be available where needed, and must be of the appropriate revision....”

The Guidance goes on to provide the following schematic diagram:



The Maritime Advisory Board consider it difficult to conceive a Safety Management System (SMS) which would not refer to external documents, including operating and maintenance manuals and moreover believe there may be positive benefits in doing so with respect to managing the size of and burden imposed by the SMS. The implication of this finding is that the externally referenced documents must have the characteristics of controlled documents in order to be auditable.

Investigating further, it was found that the International Maritime Organisation (IMO) has produced regulation and guidance with respect to the contents of manuals and, on occasion, document formats in a number of Conventions, Resolutions and Circulars across various activities, including, inter alia:

1. Oil Record Books
2. Cargo Record Books
3. Training Manuals
4. Qualification and training records
5. Shipboard Marine Pollution Emergency Plan (For Oil and/or Noxious Liquid Substances)
6. Loading and Stability Manuals
7. Cargo Stowage and Securing Manuals
8. Mobile Offshore Drilling Units
9. Ballast Water Control
10. Inert Gas Systems
11. Procedures and Arrangements for chemical carriers
12. Crude Oil Washing

It is interesting to look at some of these provisions in more detail. MSC/Circ.745 of 13 June 1996, states, with respect to Cargo Stowage and Securing Manuals:

“The purpose of these guidelines is to ensure that Cargo Securing Manuals cover all relevant aspects of cargo stowage and securing and to provide a uniform approach to the preparation of Cargo Securing Manuals, their layout and content.”

The guidance has a clear objective of providing a uniform approach to the preparation of manuals with respect to their layout and content. These objectives are developed further in MSC/Circ.920, 15 June 1999, with respect to Model Loading and Stability Manuals by adding provisions with respect to terms, abbreviations, symbols, and index:

1 The Maritime Safety Committee, at its seventy-first session (19 to 28 May 1999), noting the need for Administrations and industry to be provided with guidance on the preparation of loading and stability manuals, using a uniform layout as well as agreed terms, abbreviations and symbols for the correct use of such manuals by mariners, approved the Model Loading and Stability Manual set out in the annex.

MODEL LOADING AND STABILITY MANUAL

Table of contents

Section 1 - Identification and approval

Section 2 - Guidance to the master

2.1 Introduction

2.2 Terms, symbols and units

2.3 Explanations to the manual

2.4 Operation of the ship

2.5 Typical approved loading conditions

2.6 Control of stability, trim and longitudinal strength

Section 3 - Technical information (Category 1 and 2)*

3.1 Capacity plan

3.2 Cargo space information

3.3 Tank space information

3.4 Hydrostatic particulars

3.5 Lightship particulars

3.6 Load line particulars

3.7 Stability limits

3.8 Longitudinal strength criteria

3.9 Other operational restrictions

Section 4 - Reference information (Category 3)*

4.1 Inclining experiment report

4.2 Intact stability criteria

4.3 Other information

In Resolution A.787 (19) adopted on 23 November 1995, as amended by res. A.882(21) adopted 25 November 1999 on Procedures For Port State Control the IMO states:

"Manuals, instructions, etc.

3.5.51 The PSCO may determine if the appropriate crew members are able to understand the information given in manuals, instructions, etc., relevant to the safe condition and operation of the ship and its equipment and that they are aware of the requirements for maintenance, periodical testing, training, drills and recording of log book entries."

It is clear the IMO has not failed to recognize the benefits of specifying layout and contents for some safety critical manuals in the past and has empowered Port State Control Officers to establish crew familiarity with manuals and instructions more generally. This audit task must necessarily be somewhat difficult where there is no requirement or specification for a manual.

IACS has also produced guidance, in its Recommendation 71 – Guide for the Development of Shipboard Technical Manuals, as to what a manual should contain:

"2. Background

A shipboard technical manual is a generic term for any document that explains how to use, maintain and operate the ship and its equipment. A technical manual is an essential part of the product and its usability has considerable importance for the ship operators. Accordingly the provision of suitable shipboard manuals should be recognized as a major responsibility area."

It is clear that IACS also have not failed to recognize the importance of appropriate manuals for ship operation and describe it as "a major responsibility area", although upon whom the responsibility devolves is less clear. The guidance goes on to state:

"6.1 General

Information should be accurate and complete. Text should be clear and concise. Sentences should be as short and simple as the subject allows. Paragraphs should be short. Technical descriptions should be system or function based. Instructions should be procedure based. The information should be organised in a hierarchical and consistent manner by use of headings. Step numbering should be used to support the structuring into levels of information. Illustrations (photo, drawings, and graphs) should be used to support information and instruction text.

6.2 Categories of information

The information should be arranged in categories according to their use. The following categories of information may be applicable:

- | | |
|---|---|
| <i>a) Purpose and planning</i> | <i>(what is the system/equipment for);</i> |
| <i>b) Handling, installation, storage and transit</i> | <i>(how to prepare it for use);</i> |
| <i>c) Technical description</i> | <i>(how it works);</i> |
| <i>d) Operating Instructions</i> | <i>(how to use it);</i> |
| <i>e) Fault action list</i> | <i>(how to restore operating condition)</i> |
| <i>f) Maintenance instructions</i> | <i>(how to keep it working);</i> |
| <i>g) Maintenance schedules</i> | <i>(what is done when);</i> |
| <i>h) Parts list</i> | <i>(what it consist of);</i> |
| <i>i) Modification instructions</i> | <i>(how to change it),</i> |
| <i>j) Disposal instruction</i> | <i>(how to dispose of it).</i> |

Applicable sections depend of the complexity of equipment. Technical manuals should as a minimum include the information categories (c) – (h) arranged in a sequence according to the list above."

And;

"6.3.1 The content should explain how the various components are built, their individual function and how they interact with other components in a system. Drawings and graphic presentations should support written text.

- Information should include:*
- technical data, preferably in summary or tabular form, such as dimensions, weights, clearances, capacities, environmental requirements;*
- means of verifying technical data, such as measurement and testing equipment,*
- recommended tests, limits."*

The research did not identify general requirements for equipment manufacturers, or any other party for that matter, to produce operating and maintenance manuals to a common standard for marine applications. Some specific exceptions were identified and are relevant to the reported concern. The research did establish that externally produced operating and maintenance manuals are likely to feature in SMS and should, by implication, have the characteristics of controlled documents, permitting them to be audited.

It is clear that past IMO guidance has recognised the benefits of adopting standards for manuals across a range of safety critical activities and IACS recommendations substantially support this approach. There appears to be a stark contrast between what is recommended and what actually appears in the workplace. It is clear that if the principles outlined were applied more widely, they would address many of the concerns raised in the initial report and evidenced by the accident statistics and opinion canvassing exercise.

4. The Solution

Report text: “The style and presentation of engine operation & maintenance manuals should be subject to review and a set of minimum standards agreed and imposed by the relevant classification societies. In these days of inexpensive desk-top publishing, manufacturers could easily arrange for a bespoke publication to be printed and presented from its database.”

***CHIRP* Comment:** From the foregoing it is clear the proposed solution is worthy of consideration and development. The Maritime Advisory Board believes the adoption of standards for technical/operational documentation offer the potential to provide an element of consistency through a diverse equipment/personnel environment, reducing the risk of human error and promoting operational integrity and consistency.

Conclusions

The reported incident combined with the evidence gathered through raising the issue in CHIRP FEEDBACK, MER and other sources, including the collective experience of the Board, endorses the reported concern.

From the discussion of the issues outlined above the Maritime Advisory Board suggests the main conclusions are:

1. Seafarers are expected to assimilate different equipment fits quickly and perform to high operational standards.
2. Seafarers are expected to be able to move from ship type to ship type with few restrictions; this flexibility is essential for the efficient management of human resources.
3. Seafarers are likely to encounter equipment fits on which they have not been specifically trained.
4. Strict equipment type controls could promote consistency across the world fleet, but may tend to restrict suppliers and innovation.
5. Strict “type rating” of personnel could assist seafarers in meeting the requirement to join ships and perform to high operational standards quickly, but this may tend to restrict the flexibility of the workforce.
6. Access to a wide and competitive marketplace for equipment is essential operational and commercial reasons.
7. It is widely recognised the standard of manuals provided to seafarers varies greatly in terms of specificity, content, language and presentation and is often poor, leading to an increased risk of human error. The drivers in manual production are not necessarily the needs of the end user, but may be “defensive engineering and liability practices”.
8. The absence of a system for document control for manuals provided by the manufacturer means the manufacturer loses the opportunity to notify the owner of relevant updates and product developments and therefore such manuals as are provided are likely to be out of date after a relatively short period.
9. Manuals are not necessarily supplied in a language in which the crew are proficient and this, coupled with the quality issues outlined must represent a significant increase in the risk of errors being made either by failing to interpret the manual correctly or failing to refer to it at all.
10. Integrated systems pose particular challenges with respect to the provision of effective operating and maintenance manuals and those challenges are not always met.
11. The failure to supply good quality technical/operating manuals or supplying manuals which are hard to understand and/or inadequate operating instructions has contributed to a number of marine accidents.
12. A logical consequence of the failings listed in item 11 is personnel being unfamiliar with equipment and/or not trained in its use and these factors have also contributed to a number of marine accidents.
13. Other safety critical industries and transport modes have recognised the importance of technical/operational documentation and established controls to ensure adequate and consistent standards.
14. The IMO, whilst it has recognised the importance of establishing controls to ensure technical/operational documentation is of an adequate and consistent standard in limited applications, has not applied these principles more generally.
15. Whilst the relevant recommendations and guidance are available, there appears to be a stark contrast between what is recommended and what actually appears in the workplace.

16. Whilst Port State Control authorities have powers to audit this area, their effectiveness is constrained by the absence of an auditable standard.
17. Equipment manufacturers do not generally differentiate their products in the market place on the quality of their manuals and, in this sense; manuals should not represent a significant commercial issue.
18. The absence of an agreed standard means good quality documentation is a “cost option” invested in by a discreet sector of the ship owning/operating community, when it should be provided to all.
19. The adoption of standards for technical/operational documentation offer the potential to provide an element of consistency through a diverse equipment/personnel environment, reducing the risk of human error and promoting operational integrity and consistency.

Recommendations

Following these conclusions the Maritime Advisory Board makes the following recommendations:

1. Manufacturers of equipment for safety critical marine applications across life saving, cargo operating, navigation, communications and engineering disciplines should provide operating and maintenance manuals to a common document standard “using a uniform layout as well as agreed terms, abbreviations and symbols for the correct use of such manuals by mariners.”
2. The use of simplified technical vocabularies and icons should be encouraged. If used, reproductions of photographs and drawings should be of an adequate standard and documents should be available in an agreed number of languages.
3. A relevant authority should verify the compliance/standard of documentation at the design/approval/acceptance stage and audit its continued compliance thereafter.
4. Documents produced to the standard should be controlled and include notifications to manufacturers to accommodate through life operational changes e.g. a change of ownership, crew nationality, etc.
5. Where integrated systems are fitted, a manual covering the entire system should be available. Particular attention should be paid to Failure Mode Effect Analysis for such systems.
6. Training regimes should be amended where necessary to ensure familiarity with the use of manuals produced to the standard. Thereafter, provided the seafarer continues to encounter manuals produced to the standard, efficient familiarisation and operation should be promoted.

The CHIRP Maritime Advisory Board

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Annex 1 - IACS Recommendation 71 - Guide for the Development of Shipboard Technical Manuals

GUIDE FOR THE DEVELOPMENT OF SHIPBOARD TECHNICAL MANUALS



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No.71 Guide for the development of shipboard technical manuals

(Sept. 2000)

1. Scope

This guide provides criteria for the development of user friendly technical manuals for operation and maintenance of the ship and her equipment by means of easy retrieval and use of information.

This guide is not extensive but includes essential requirements concerning:

- manual form which is the physical arrangement and appearance of the manual;
- manual contents which is the information included in the manual;
- manual structure which is the logic of contents and how these related and belong together,
- manual presentation which is the layout and graphical appearance of the manual.

2. Background

A shipboard technical manual is a generic term for any document that explains how to use, maintain and operate the ships and its equipment. A technical manual is an essential part of the product and its usability has considerable importance for the ship operators. Accordingly, the provision of suitable shipboard manuals should be recognised as a major responsibility area.

3. Application

The criteria of this guide should be applied for the development of all part manuals covering operation and/or maintenance of the ship and its equipment. This guide is applicable for both hard copy paper manuals and electron interactive manuals.

4. General

A manual should preferably apply to one equipment model or variant only; if more models or variants are included they should be dealt with in separate sections and it should be clearly stated which section apply to each model or variant and how each model or variant can be identified.

5. Form and Format

The manual form is the physical arrangement and appearance of the manual.

Specification of the manuals form and format should be based on a thorough assessment of the operators' need. The need depends on type of ship and equipment, operational characteristics and maintenance schemes.

5.1 Form

The manual form may include:

- reference books (hard copies and/or electronic versions);
- wall charts,
- label information.

Essential operating instructions and warnings should be repeated as labels or charts to be located on, or in the immediate vicinity of, the operating stand.



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5.2 Format - Hard copies

The manual format should be Standard A4 (or A5 for pocket versions).

5.2.1 Manual updating

Document control is essential. Manuals must be kept updated to reflect amendments and modifications. The manual bindings should be adapted to support efficient updating of information.

5.3 Format - Electronic version

5.3.1 Data format

Electronic manuals should be delivered in open standard format. Production of manuals should not be based on conversions between formats. Conversions between text editors or different versions of the same editor may often lead to loss in functionality and content.

5.3.2 Updating

The information should be arranged for easy updating. On-line connection will allow for direct updating (downloading) of information from manufacturer to ship operators' and onboard terminals.

6. Contents

The manual content is the information included in the manual.

6.1 General

Information should be accurate and complete. Text should be clear and concise. Sentences should be as short and simple as the subject allows. Paragraphs should be short.

Technical descriptions should be system or function based. Instructions should be procedure based. The information should be organised in a hierarchical and consistent manner by use of headings. Step numbering should be used to support the structuring into levels of information.

Illustrations (photo, drawings, and graphs) should be used to support information and instruction text.

6.2 Categories of information

The information should be arranged in categories according to their use. The following categories of information may be applicable:

- | | |
|--|--------------------------------------|
| a) Purpose and planning | (what is the system/equipment for); |
| b) Handling, installation, storage and transit | (how to prepare it for use); |
| c) Technical description | (how it works); |
| d) Operating Instructions | (how to use it); |
| e) Fault action list | (how to restore operating condition) |
| f) Maintenance instructions | (how to keep it working); |
| g) Maintenance schedules | (what is done when); |
| h) Parts list | (what it consist of); |
| i) Modification instructions | (how to change it); |
| j) Disposal instruction | (how to dispose of it). |

Applicable sections depend of the complexity of equipment. Technical manuals should as a minimum include the information categories (c) – (h) arranged in a sequence according to the list above.

6.3 Technical description

The purpose is to provide shipboard personnel with appropriate understanding (familiarisation) of the build up and function of components and systems. The technical



No.71 description should support the personnel in applying operational and maintenance instruction correctly and efficiently.
(Con't)

6.3.1 The content should explain how the various components are built, their individual function and how they interact with other components in a system. Drawings and graphic presentations should support written text.

Information should include:

- technical data, preferably in summary or tabular form, such as dimensions, weights, clearances, capacities, environmental requirements;
- means of verifying technical data, such as measurement and testing equipment,
- recommended tests, limits;

6.3.2 Technical descriptions should be system or function based. Illustrative presentation should preferably be used. The information should be logically arranged by break down of systems in a hierarchy of levels. The upper levels should provide a clear descriptive overview of the main system and its sub-systems. Reference should be given to detailed sub-system information in lower levels (step numbering).

6.4 Operating instructions

The purpose of operating instructions is to provide complete information and procedures for safe operations under normal, special and emergency conditions.

They should normally include:

- Background information;
- operating instructions;
- treatment of malfunctions.

Operating instructions should be suitable for use as training aids and provide basis for development of further training manuals.

6.4.1 Background information should provide the necessary background for the user to operate correctly under all conditions. Depending on the complexity of a system the information should include:

- the purpose, location and effect of operating controls and instruments described in logical order according to operating sequences;
- rules to be observed and tasks to be performed before, under and after operation;
- details of tests the operator should carry out to verify functional performance;
- limits and methods for assessing malfunction;
- hazardous condition which could arise from errors or malfunction identified,
- any team action or drill required.

6.4.2 Operating instructions should provide full details of the procedures to be followed in preparing, starting, running and shutting down a system under normal and emergency conditions.

Operating instructions should be procedure based and organised into hierarchical levels. Headings and step numbering should be used to support the sequence of application.

6.4.3 Higher level operating instructions should be limited to the essentials of the procedures and their effects. Flow charts, graphic or tabular forms should preferably be used to show the sequence of events. Further details should be referred to next level instructions or to background information.

6.4.4 The operating procedures should:

- appear in the order they are to be carried out;
- be set out in a step-by-step sequence;
- on graphic illustrations and associated text, use the same names as those used on labelled components and controls,
- use present tense for descriptions and imperative for instructions.



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6.4.5 Each operating procedure should include, as applicable:

- brief description, explaining the purpose of the procedure;
- list of major components involved;
- checks required to ascertain availability of safe function;
- step-by-step instruction for start up of the system ;
- operating limitations, checks and adjustments for safe and efficient operation;
- warnings and cautions with the identification of the hazards and hazard consequences to which they refer as well as any critical time constraints. Warnings and cautions should be placed on the same page and immediately before the step to which they apply.
- emergency actions to be taken in response to alarms and warnings.

6.5 Fault action list

Potential malfunctions that can be foreseen should be listed and appropriate corrective actions specified.

6.5.1 Malfunctions and faults should be listed in logical order according to the systems and functions in which they appear. Faults should be identified by their resulting characteristics (alarms, readings, abnormal sound, smoke or other detectable effects).

6.5.2 The list should include, as applicable, reference to relevant procedures for restoring normal condition.

6.6 Fault actions procedures

Procedures for treatment of malfunction should include:

- actions by the operator;
- actions by the maintenance team;
- actions requiring specialistic treatment

6.6.1 Operators' treatment of malfunction should include brief instructions for immediate actions and guidance and procedures to be followed in detecting, correcting and reporting any malfunction or failure that occurs, including:

- **Alarms:** their purpose, function, location of detectors and indicators, settings, automatic actions and manual actions to be taken;
- **Fault diagnosis** should be limited to those tasks the operator could be expected to do, such as noting malfunctions, abnormal symptoms or indications and recording alarms and trips,
- **Corrective procedures** should be limited to those tasks the operator could be expected to do, such as accepting alarms and resetting of trips, starting-up standby auxiliary plants and shut-down of malfunctioning components.

6.6.2 First level procedures for immediate actions should be available at the operating position. They should be brief, preferably in flow charts.

6.7 Maintenance instructions

The purpose is to provide the user with the information necessary to enable him to ensure that the ship and equipment is correctly maintained.

6.7.1 The content of maintenance instructions should include all tasks required to keep the ship and equipment operating to the intended performance and lifetime. Information should include the skills, materials and tools required for typical groups and levels of maintenance.

6.7.2 Instructions should include identification of potential hazardous conditions, which could occur, and necessary precautions such as permits, warnings and monitoring.



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- 6.7.3 The information should be divided into sections applicable to:
- tasks within the capability of onboard personnel during normal operation;
 - tasks within the capability of expert maintainers attending on board,
 - tasks carried out by expert personnel in a well equipped repair yard

First level instructions for onboard personnel should be limited to essential instructions for condition monitoring and periodical maintenance. First level instructions should refer to underlying levels for more detailed information.

6.7.4 The instructions should be grouped into routine maintenance, inspections and tests, overhaul and fault diagnosis. They should be arranged in logical relation to the maintenance schedules and presented step-by-step in the order they are to be applied.

6.8 Maintenance schedules

The purpose is to provide the user with the complete cycle of maintenance operations.

6.8.1 The content should include lists for all maintenance tasks to be carried out at specified intervals. Recommended condition monitoring or inspection should be incorporated. The listed tasks and the associated skills required should be compatible with the those indicated in the maintenance instructions.

6.8.2 Schedules should list maintenance tasks according to type of skills and be arranged according to the frequency of tasks. Each task should refer to the applicable maintenance instruction.

6.8.3 The individual maintenance schedules for components and systems should be consolidated into master schedules covering maintenance of complete systems, preferably the ship with all equipment in one schedule.

6.9 Parts Lists

The purpose is to provide the user with a means of identifying any part that may be referred to in the operation or maintenance of a component or system.

6.9.1 The contents of the parts list should contain the information necessary to identify and locate all parts, options and accessories, whether renewable or not, with detail of sources and mode of supply.

6.9.2 The parts list should include an illustration of the part and its position, preferably in exploded view. The part reference name should be used consistently throughout the manual.

7. Structure and Presentation

7.1 Structure

The manuals structure represents the logic of contents and how these relate and belong together.

The structure is expressed through the arrangement and organisation of information in the manuals. The operator, having learned the logic of the structure, should find it easy to locate and retrieve the correct information.

7.1.1 Encoding structure in text can be done using styles as known from common word processors or by using standard *document mark-up languages* like SGML [ISO 8779] or XML [W3C XML recommendation]. Mark-up languages also have the important advantage of separating structure from layout and presentation.

7.1.2 User categories

The need for information depends on the users' tasks, their competence and skill, operational characteristics and maintenance schemes. Ship builders, shipboard personnel



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and land-based personnel may need different type and level of information. This may require a split into levels of information to suit the various user categories.

If the manuals have to cover several categories of users the information should be arranged and identified in separate sections to meet each user category's need (ref. 5.2). Accordingly, information in each section should be expressed in a way that is easily comprehensible to the intended users (e.g. an expert engineer may need level of information that is not comprehensible for the average onboard personnel).

7.1.3 Levels of information

The manual content should be organised in a hierarchy of levels, supporting the presentation of content at different levels of detail. The top level should provide an overview of components, systems and connected essential instructions or data. The top level should be brief and refer further details of information to the following levels.

7.2 Presentation

The manual presentation is the layout and graphical appearance of the manuals.

Presentation reflects the structure of the content. The primary purpose is to support information availability (content semantics and structure), e.g. using numbered lists or easing comprehension with illustrations.

7.2.1 Text

The legibility should be optimised by composing the text in accordance with the users' need under the circumstances in which it will be used. Brief sentences should be used. Each statement should be limited to a single task.

7.2.2 Illustrations

Illustrations are excellent means of providing the user with a visual introduction to the systems or components.

Photos or graphic drawings should be used for describing equipment details.

Graphics should be used to provide a view of:

- internals (exploded view);
- arrangements (location of components and their connection in a system),
- wiring diagrams.

7.2.3 Balance text and illustrations

The users' need should be the first consideration when deciding the mix of text and illustrations. Use of illustrations is recommended where they will convey information more quickly or clearly than text.

Illustrations should be used to create an overview and support the text in the upper level information. Text and illustrations should be entirely complementary to shorten and simplify the presentation.

The overview illustration may have references to next level information (more detailed illustration and text).

7.2.4 Technical terms

Terms and their definitions should also be given in a glossary including applicability and presentation of:

- units;
- terminology;
- signs and symbols,
- abbreviations.

Technical terms, which are not common to the onboard personnel, should be explained in the text when they are first used. In the text a component should be referred to by its name.

7.2.5 Cross-references

Any references to information in another part of the manual should include the number



No.71 of the paragraph, page, figure or table.

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7.2.6 Warnings and cautions

The treatment of warnings and cautions should be explained in the preliminary pages of the manuals. Details should be given of the treatment of general warnings and cautions that apply throughout the text and of specific warnings and cautions that apply at particular points in the text.

Warnings and cautions should be in order of priority, the most important appearing first.

