LASH FIRE

LASH FIRE GUIDELINES

Guidelines for crew-centered fire safety design

DEVELOPED FOR SHIP OPERATORS

Version 01 - 2023

LASH FIRE GUIDELINES - Guidelines for crew-centered fire safety design

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Introduction

Paying respect to the crew's practical needs during fire safety design will translate into effective action when a fire occurs. This guide is intended to help the shipping company fulfil that goal in a ship newbuild project.

Representing crew needs in fire safety design

Managing an onboard fire is a time sensitive process where smooth action and collaboration amongst the crew is key to good outcomes. These actions and interactions, however, are heavily influenced by ship design. Information that is difficult to collect, systems that create confusion and disturbances in the bridge environment are all factors that may lead to delays, and ultimately, to an aggravated fire scenario.

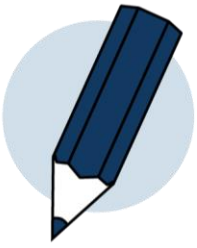
Fire safety design is often treated as a purely technical issue, with a focus on technical performance and rule compliance. But when a fire occurs, gaining control requires correct and timely actions from the crew. Providing the crew with the right tools for this job – purposefully designing onboard environments, systems and tools according to their needs – is an underused and powerful approach to fire safety. This guide sets out from an activity-centered perspective, that is, a strong emphasis on what the crew needs *to do* in the event of fire, and how those actions can be supported. The purpose of this guide is to show how such an approach can be applied in the early phases of a ship newbuild project.

INVESTIGATE

For the environment at hand, investigate crew activities in a fire scenario. Describe general goals and tasks for those activities.

DEFINE

Identify hazards associated with the tasks. Compare tasks, the related hazards and design principles and define design requirements. How can the crew be helped to accomplish the goals through the design of layouts, systems, resources and tools for collaboration.

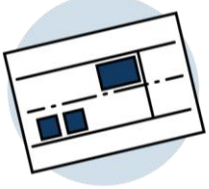


COMMUNICATE

Communicate with project stakeholders:
Internally, to advance crew interests in the project;
Externally, communicating design requirements to the design firm or suppliers.

REVIEW

Review design drafts or supplier products and the materials produced in the process.



Who is this guide for?

The intended user of this guide is a member of the newbuild design team within a shipping company, responsible for fire safety issues. In a situation where no such representation exists, the guidance could also be used by a crew member (such as a designated fire chief) to create materials for communication with their land organization.

What does the guide contain?

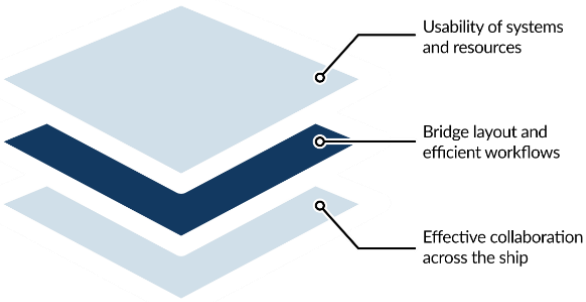
The guidance in this document covers the early phases of a newbuild project, where crew needs can still be taken care of in a cost-effective manner. Guidance is exemplified through a case of bridge design for fire safety - the bridge working stations and installations used to detect, monitor and coordinate the response to a fire scenario (the Safety Center).

When using the guide, you will be taken through a process of **four steps** - investigating crew tasks, transforming that information into design requirements, communicating with design process stakeholders, and reviewing design and equipment proposals. An outline of these steps is also presented on the previous page.

The guide includes an Excel worksheet where you keep track of your progress. Besides working as a suggestion of how to structure your design requirements, it also contains information that can be used a starting point for specifying bridge fire safety systems.

Examples of applying the guide

The examples provided for the different steps of the process build on a real case study on bridge design. This case was developed together with a Swedish shipping company during a newbuild project, and even though the outcomes from that case may not be relevant in other newbuild contexts, they may still serve as an inspiration.



Layers in fire safety design

When investigating the design of an environment where the crew will be active during a fire incident, it is good to think in terms of layers, going from low-level to high-level design issues. Throughout this guide, three general layers will be used to structure activities and outputs from the process:

1. **Systems and resources** should be effective and easy to use, both when used in isolation and in combination with each other.
2. **Layouts** should support common workflows and interaction between members of the crew.
3. **Collaboration** should be supported between the designed environment and groups in other locations on board.

The purpose of using this layered approach is to encourage discussions around fire safety design that go beyond individual systems and detailed design issues (such as graphical design). Effective fire management depends on close collaboration between many crewmembers, fulfilling many different functions. Supporting that collaboration is just as important as providing systems and resources that are easy to use.

Environment	Goal	Task	System	Hazard	Requirement	Comment

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Keeping track of information

When working with design requirements you will be producing a lot of information that needs to be managed in a structured way. If you already have a way of managing requirements, we recommend that you stick to that structure. In this guide we propose a simple Microsoft Excel sheet for keeping track of information associated with tasks and requirements. The table has the following columns:

a) **Environment** (such as bridge or ECR), to allow filtering of requirements per environment

b) **Goal** represents what should be achieved with an activity, and is primarily used to help with mapping out work tasks

c) **Task** descriptions help to make sure that design proposals match what the crew actually needs to do in a fire scenario

d) **System**, to allow filtering of requirements per individual systems

e) **Hazard** is included as a tool for communication, and to give the designer more context for the requirement

f) **Requirement** is the design requirement communicated to the design firm or suppliers

g) **Comment** is the place for any additional information that may be relevant

The purpose of this structure is to present the requirements so that a design firm, shipyard or supplier also understands the reasons for requirements. Another purpose is to provide grounds for the review of design drafts and suggested products.

EXAMPLE – DESIGN REQUIREMENT DATABASE

Environment	Goal	Task	System	Hazard	Requirement	Comment
Bridge	Detect	Perceive alarm	Fire alarm system	Alarm missed	Alarm signal is clearly audible.	
Bridge	Detect	Interpret alarm message	Fire alarm system	Alarm misunderstood: location, faulty/real	Alarm message conveys location of detector in a way that is recognizable to crewmembers. Message includes drencher zone, heat/smoke level.	
Bridge	Assess	Assess heat spread	Fire alarm system	A rise in heat / spread of fire is missed	Clear presentation of changed detector state, e.g. additional detections, rise/decline in temperature.	
Bridge	Assess	Assess smoke spread	Fire alarm system	Smoke density and/or spread is underestimated, smoke spread is mistaken for fire spread	Clear presentation of changed detector state, e.g. additional detections, rise/decline in smoke concentration. Ability to review smoke concentration in relation to heat measurements.	
Bridge	Assess	Control for dangerous goods	DG information	DG information is missed or insufficient	Information on Dangerous Goods must be kept in a way that is easy to access and understand in a crisis situation.	

Investigate crew activities

Fire management builds on cooperation amongst the crew and involves the use of many different technologies. To maximize performance, this system of people and technologies must be designed for smooth interaction. The starting point of the design process is to map out the goals and tasks associated with fire management.

By investigating what crewmembers actually *need to do* when managing a fire, we can specify requirements that ensure that systems and environments fulfil their purposes. Onboard working environments, systems and resources should be designed to support the crew, and the first step in the development of design requirements is to create a truthful picture of their work.

This chapter presents a workflow for determining the goals and tasks associated with on-board fire management in a specific environment. Descriptions of goals and tasks may fulfil several purposes in the newbuild process. For example, while design requirements can become quite detailed, you should return to these work descriptions when design drafts are reviewed, to see whether a proposed design allows the crew to perform their activities successfully.

When crew activities are investigated, information can come from many different sources, such as crewmember interviews, system walkthroughs, workshops and drill debriefings. At the end of this chapter, a few such methods are described.

EXAMPLE – POSSIBLE CONSEQUENCES OF A PURELY TECHNICAL FOCUS

Even though a fire safety system is approved and has the right technical capacity, there is still no guarantee that it will be put to effective use in a fire incident. For example, consider the 2014 fire on the Norman Atlantic. When this passenger ferry was sailing in the Adriatic sea, a fire broke out in the roro space on deck 4. The crew was alerted to this fact by a fire alarm received at the bridge. However, because of the confusing placement and labelling of valves in the drencher operating room, the drencher system was activated on the wrong deck. This demonstrates that if the practical activities surrounding drencher activation are not considered during design, the performance of those activities may be undermined.

Map out goals and tasks

The starting point of the process is to develop a realistic image of the fire management activities performed by the crew in a certain environment. This chapter exemplifies how core *goals* in bridge activities, often performed by the fire chief, can be broken down into *tasks*. For any other environment, some goals and tasks may be similar, while others will need to be added or removed.

Goal: a desired result of fire management activities

Task: something that the crew needs to do in order to accomplish the goal

When

Mapping out goals and tasks is the starting point of crew-centered activities in a newbuild project, but this type of work could also be done proactively, well before a new project has started. Once the mapping is done, the materials can provide a head start when a newbuild project begins. Making the details of work visible like this may also serve other purposes, for example, to discover improvement possibilities on an existing ship, to structure training, or to review work procedures.

How

For the present case, five basic goals are considered:

- **Detection** of the fire
- **Confirmation** of the fire and its location
- **Assessment** of the fire's intensity and spread
- **Coordination** amongst the crew, both on and off the bridge
- **Extinguishment** of the fire using fixed systems and manual interventions

The purpose of starting with a small number of goals is simply to make task identification more manageable. These goals were chosen because to a large extent, they represent the most common phases of fire management.

When the core goals have been decided, the next step is to review each goal and think of underlying *tasks*. A task is simply anything that the crew needs to do in the studied environment in order to accomplish the goal. Some tasks are concrete (like manual work tasks) and other may be more abstract (like assessment or information sharing). In the box below, a few examples of tasks are given for the goals *Detection* and *Assessment*.

Tips & tricks

Make sure that the persons involved in goal and task identification have relevant experience of operational work. Even if you are a senior officer with a long work experience, it is easy to forget the details of everyday activities when you do not perform them regularly. It is good practice to involve currently operational personnel in the analysis.

EXAMPLE – TASKS RELEVANT FOR FIRE DETECTION

Goal	*Tasks*
Detection	- Perceive the alarm
	- Interpret the alarm message
Assessment	- Assess heat spread
	- Assess smoke spread
	- Control for dangerous goods
	- Assess external factors (e.g. weather, other traffic, external aid)

Fill out the worksheet:

Goals and tasks can be added to column B and C in the worksheet. You can already start tagging systems (in column D) or add comments (in column G) that you think may be useful later on.

Interviewing users

Conducting interviews is one way of identifying crew needs. Being able to quote crew experiences can be a powerful way of communicating the importance of design requirements.

When

A good time to use interviews is when you need concrete examples from operations about positive and negative experiences of fire safety installations. Such experiences can provide shortcuts when defining requirements.

How

Interviews can be performed either locally or remotely. In cases where on-line interviews is the only option, video streaming can be used for task or equipment demonstrations. If the interview is centered around fire safety systems, however, it is advisable to carry out the interview onboard, making it easier to review and discuss existing installations.

Preparations for interviews include:

a) Deciding the goal with the interview.

b) Preparing an interview guide. This could include specific questions, but also only discussion topics. See the next page for an example. Include your interview goal and a couple of neutral probes.

c) Planning for how to collect the data. The benefit of recording an interview is that you can re-listen if you are uncertain of what was really said, but transcribing an interview can also be very time-consuming. A good option is to make notes during the interview and record as a back-up.

d) Informing interviewees on what their participation means, for example how the collected data will be used, and whether their participation is anonymous.

After the interview there are many ways of processing the data. One suggestion is to go through your notes and sort findings under activity goals (see the previous chapter). It is likely that you see some requirements forming already. If you use the worksheet, you can start trying to enter these requirements, or just add them as comments for now and return to them in the next step.

Tips & tricks

The purpose of your interview is not necessarily to review a specific system, so if interviewee talks about something they like or dislike, follow up with questions on *why that is*. For instance, say that you hear that systems with physical buttons are much better than those with on-screen buttons. Follow-up questions can then show that the person thinks so because the on-screen buttons in the currently installed system are hidden behind a menu and therefore inaccessible. In this example, the user need could be that buttons for specific actions must always be visible, but not necessarily physical buttons.

When interviewing, it is important to give participants enough time to gather their thoughts. Do not move on to the next topic too quickly. If you stay silent, the person will likely continue talking about the subject.

OTHER WAYS TO ENGAGE WITH USERS

There are many other methods that can be used to collect data and insights from the crew. Some example are:

- **System walkthrough:** Let a user demonstrate and explain existing systems for you. Pay attention to crew-made notes or instructions attached to systems – these can be an indicator of shortcomings in systems or interfaces.
- **Fire drill debriefing:** arrange a systems-oriented fire drill debriefing. Inform crewmembers before the drill that you will spend some time after to discuss fire-related systems and ask them to pay attention to pains and frustrations related to systems during the drill.
- **Collaborative mapping session:** Crewmembers can be invited to carry out the methods suggested in this guide, such as mapping or creating requirements.

Example – interview guide

This is an example showing how an interview guide can be structured. The example is created for an imagined interview with a fire chief.

In this example we have chosen to focus on topics and question formats that suite a free-flowing and flexible interview. You can also construct specific questions beforehand if you prefer that. No matter what you prefer – do not forget to ask follow-up questions!

Interview goal

What are important factors to consider when selecting fire alarm panel?

Introduction

- Welcome
- Purpose of interview: To learn about your experiences of fire panels and ideas for improvement
- Conditions (anonymity, handling of data etc.)
- Warm-up questions (if needed, e.g. role, years on the ship, previous workplaces)

Alarm system walkthrough

- Receiving alarm(s)
- Alarm interpretation
- Assessing intensity and spread
- Silencing alarms
- Relaying information to others

Success factors and frustrations

- What works well?
- What things frustrate you?
- What improvements could be made?

Wrap-up

- Thank you and goodbye

Question openings

Tell me about…

Can you describe…

Can you show me how you…

Follow-up questions

Do you have an example?

Why is that?

Could you explain further?

Did this procedure/system ever fail?

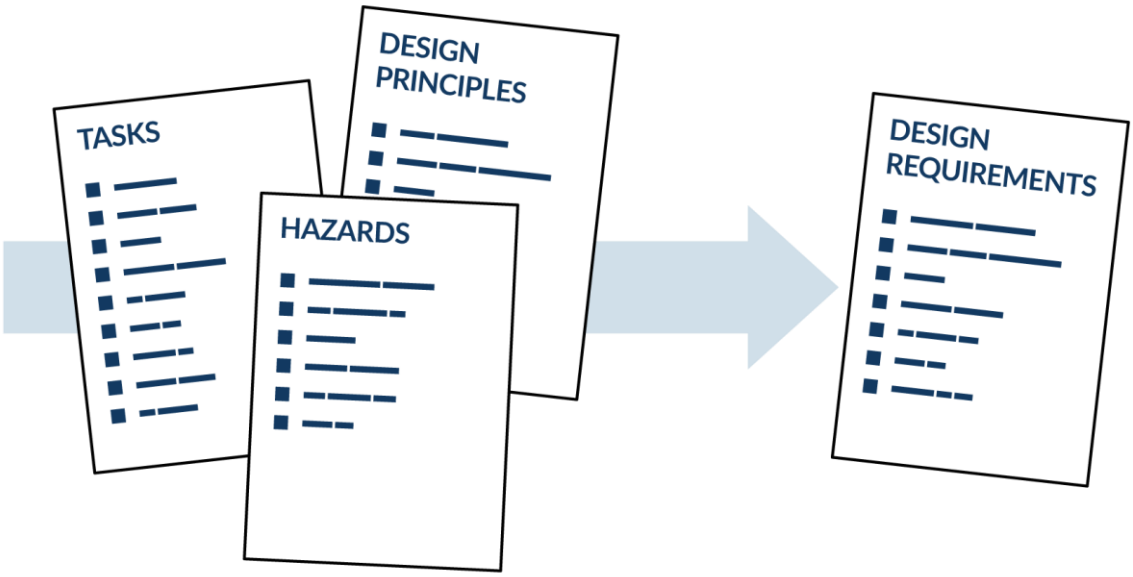
What would be the consequences if..?

Define requirements

When you define design requirements, you investigate the connection between practical work tasks and the environments, systems and tools that should support them. These requirements will be used for communication with the design firm and suppliers.

After the previous step of investigating operational goals and tasks, you now have a good foundation for defining design requirements. But stating requirements can sometimes be difficult. To that end, the guide provides two approaches. First, you will think of *hazards* that may appear due to poorly designed or implemented systems – considering what the design of environments, systems and other resources should safeguard against. Second, the guide provides a set of *design principles* that can help you see how different properties of the working environment can be made to support task performance. These principles reflect the same layered approach as the previous steps, going from the detailed properties of individual interfaces, to requirements for layout and integration, and on to requirements for interaction between bridge personnel and other work groups. You will feed the results of this process into the worksheet, and the materials can later be used for internal and external communication.

A natural starting point when discussing newbuilds or design improvements is often negative operational experiences from past or present workplaces. This kind of input can be of great value for the continued process, so when they appear, make sure to note them in the worksheet, even if you are not yet ready to process them.



Hazards

Discussing hazards related to the tasks involved in fire management has several purposes. Firstly, it may be a good way of bringing operational experience into the formation of design requirements. Talking about potential pitfalls in fire management activities, and the causes behind those pitfalls, can make it easier to see how work is affected by the design of environments, systems and equipment. Secondly, the fact that hazards exist but can be mitigated through crew-centered design may also be a strong argument in internal newbuild project discussions, and support operations as they communicate their demands. Thirdly, information about potential hazards provides the designer with more context for a particular requirement.

The hazards we are focusing on here are those that can be mitigated with improved design solutions, but whether that is the case may not always be obvious. It is better to make note of as many conceivable hazards as possible and remove irrelevant ones later, when you set the requirements.

How

When documenting hazards in the worksheet, only the hazard itself will be noted, but for use in project argumentation, it may be warranted to dig a bit deeper. Below is an example of how a hazard related to fire detection can be explored.

Task: Interpret the alarm message

Hazard: Location of detection is misunderstood

Causes: Information in the alarm message is difficult to interpret

Consequences: Response to the fire is delayed

Requirements

When setting the design requirements, you will make use of the materials you have developed in the previous steps. Requirements should be firmly rooted in the goals and tasks related to the working environment and they should counter potential hazards, but they should also live up to good practice for systems usability, layouts and crew collaboration. For the latter purpose, this guide provides a set of design principles that have been developed based on research experience and general usability principles. You will find these principles on the next page.

How

When discussing requirements for a specific task, the following series of questions can be one way of uncovering relevant information:

- *What environments, systems, tools or other resources are associated with the task?*
- *What characterizes good performance of the task and how can such performance be supported?*
- *What are hazards are associated with the task and how may those hazards be prevented?*
- *Can any of the design principles be applied to promote good performance, or to prevent hazards?*

Requirements need to be concrete enough so that the design firm can match them with solutions, and so that the shipping company design team can use them for design review. At the same time, they should not be over-specific. Very detailed requirements (for example, based on individual experience and preferences) may overshadow innovative design solutions that could have provided better answers to operational needs.

Fill out the worksheet:

Hazards and requirements are added to columns E and F in the worksheet.

Design principles

This set of design principles can help you see how properties of the working environment relate to task performance. The principles are based on insights from fire management studies on ropax ships. It is likely that different principles will be relevant at different stages of design development.

You will also find the design principles in a separate sheet in the worksheet, so that you can edit the list according to your needs.

Usability

- Text-based information is clear and informative
- Graphics replace text where appropriate
- Graphics (e.g. GA) contain only relevant information
- Safety systems are easy to read and control
- A consistent naming practice is applied in all systems and documents
- Clutter (e.g. paper handling) is minimized
- It should be possible to assess the source and validity of information, especially information that has been aggregated from different sources

Layout & integration

- There is room for parallel activities
- Disturbances between work groups are minimized
- The placement and layout of workstations enables collaboration between work groups (e.g. evacuation and OOW)
- Panels and controls are placed in a way that promotes an efficient workflow
- Resources that must be used together are placed together – consider integrating information and controls for different systems where it benefits efficiency and effectiveness
- It is possible to quickly get an overview of all system statuses

Collaboration

- Information sharing with other parties (e.g. ECR and fire groups) is supported
- Systems provide information that is easy to communicate to others
- Events and developments in other working groups are easy to monitor
- Work delegation is supported, e.g. to relieve the fire chief

Communicate with stakeholders

Getting design requirements across to other project parties is vital to ensure that crew-centered design goals are met. This communication must be clear and relevant for the receiver.

Design requirements will need to be communicated to different stakeholders, both internal to the shipping company and externally, primarily to the design firm. Different stakeholders – and different goals of communication – will require different approaches. In one forum, the objective may be to gain understanding and acceptance for crew needs. In another, the objective may be to supply enough information to guide design decisions.

The main emphasis of this chapter is on how to champion crew requirements internally, within the shipping company. Because ship design may involve trade-offs between competing needs and cost minimization is often sought, it is important to be able to frame crew needs in a way that communicates well to stakeholders without operational experience. Doing so requires that the communicator presents a compelling narrative, describing the realities of performing an activity, how the performance of that activity may affect fire safety outcomes, and potential hazards connected to design solutions.

EXAMPLE – COMMUNICATING CREW REQUIREMENTS INTERNALLY

DESIGN TOPIC - Supporting response coordination on the bridge

GOAL:

Communication - Clear and undisturbed communication must be possible with personnel both on and off the bridge.

WHY?

A noisy bridge environment makes it difficult to communicate

DESIGN CONSIDERATIONS:

Layout: Disturbances between work groups must be minimized

Layout: The placement and layout of workstations must enable collaboration between work groups (e.g. evacuation and OOW)

Usability: Sound signals from different systems must be harmonized so that co-occuring signals do not cause disturbance

Communicating internally

Getting acceptance for crew requirements may be a lot easier if they are systematically presented. This is both a matter of conveying the real working circumstances of the crew during fire management, and the consequences of not living up to their needs. The target groups for this communication will not always have knowledge about onboard fire safety, which makes it important to adapt the contents to them.

How

Different audiences may require you to focus on different types of information. When addressing safety aspect of design, it may be good to put an emphasis on hazards, but to gain acceptance for investments, direct and indirect benefits of crew-centered solutions may be equally important. In early design discussions, it may be good to focus on environments where crew needs in connection to fire safety may compete with design considerations of other stakeholders, such as those representing the passenger experience.

The materials that you have gathered in the worksheet provide many different approaches to communication. The example on the previous page shows a very condensed way of communicating a work goal, a hazard (explaining *why* it is important) and relevant design principles (expressed as design considerations). Try to think of a good narrative for your discussion, such as describing the way a certain task is carried out, and issues that may be encountered.

The example below shows how the cost-effectiveness of an integrated Digital Fire Central was assessed and confirmed in the LASH FIRE project. The argumentation behind this assessment may serve as an inspiration when costs related to different design or equipment options are discussed.

Communicating with designers & suppliers

The worksheet that you have developed is the main material used to structure communication with design firms and suppliers. We encourage you to share more than only the list of requirements per system. By including information such as tasks, hazards, and useful comments, you help your partners understand the case that they are designing for.

Remember that designers and suppliers are likely to have less experience than you when it comes to:

- The day-to-day work on a ship
- Ship fire organization
- Tasks that are carried out simultaneously or in relation to proposed designs
- Impact of onboard culture (e.g. blame-culture)

EXAMPLE – COSTS AND RISK REDUCTION

Within the LASH FIRE project, a prototype for a Digital Fire Central was developed. The prototype was implemented on a touch screen where all the information resources and system controls that might be needed for fire management were gathered into one single interface, providing a good overview and simple access to fire safety systems. The prototype was assessed for risk reduction according to the risk model developed in the project, and costs were assessed by experts in ship design and production.

Results placed the Digital Fire Central as one of the five most cost-effective solutions in terms of Net Cost of Adverting a Fatality. This means that for newbuild ropax, roro and vehicle carriers, the cost criterium of saving cargo, ship and life is far higher than the cost for purchasing, installing and maintaining such a system.

One reason for these results is that the solution belongs to a category of measures that affect the earliest phases of a fire incident, where the possibility of minimizing risks is the highest.

For more information, see the LASH FIRE Deliverable D04.6 Cost-effectiveness assessment report https://lashfire.eu/deliverables/

Review of design solutions

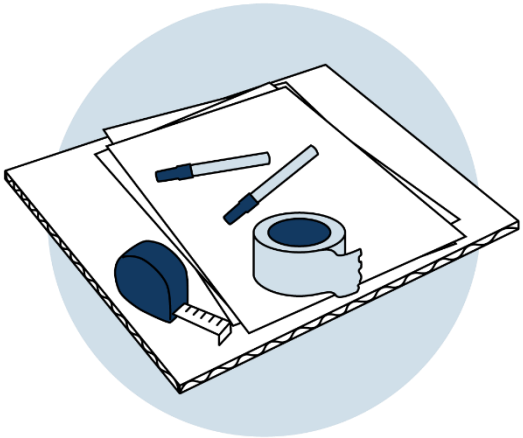
Shipping company representatives are rarely involved in actual design tasks, and therefore, reviewing design outcomes is a very important part of achieving crew-centered fire safety solutions.

Design solutions are reviewed iteratively throughout the newbuild process and as the project evolves, increasingly detailed assessments can be made. When performing these reviews, you will go back to the worksheet and your descriptions of crew tasks, hazards and requirements. But whether the review can be made successfully also depends on your review approach and whether you include people with the appropriate knowledge and background. This is an excellent opportunity to involve crewmembers with roles in the onboard safety organization.

The materials developed in the requirement worksheet can be used in several ways in design reviews. A review will often concern one specific onboard environment or system, so you can apply a filter in the requirement worksheet to bring out information relevant to the current topic. Some overarching review themes are:

- Does the design product support all of the crew tasks that are associated with it?
- Does the solution address the identified hazards?
- Does the solution live up to the relevant design principles?
- Does the solution satisfy the stated requirements?

This chapter provides guidance for two main iterations in the design process – first, reviews of ship layouts, and second, reviews of more detailed design solutions and product suggestions that appear as the project evolves.



DESIGN REVIEW
TOOLKIT

Review of layouts

When assessing layouts, it is important to make sure that the methods used allow the reviewer to gain a realistic understanding of work performance and circumstances in the envisioned environment.

There are clear limitations to review methods that only involve on-screen assessments, and even if 3D models are made available, it may still be difficult to properly assess aspects such as space requirements, room for movement, work positions or systems visibility. To complement these common approaches, you are encouraged to use methods where you experiment with the design in the real world. The box to the right gives a few examples of such methods.

- Use drawings or 3D-models to perform walkthroughs of crew tasks, simulating how the task would play out in the proposed environment. Assess if hazards, design principles and requirements can be accounted for.
- Use tape to create simple mockups of the workspace, where you can assess aspects such as distances, dimensions and line-of-sight.
- Visit an existing onboard environment and make observations (such as measures) for comparison.

Review of systems and equipment

It may often be difficult to assess and compare systems and equipment that, for example, are proposed by the shipyard, if the shipping company has no prior experience of the supplier's products. The shipyard can be expected to push for options that minimize cost and will normally not factor in values associated with practicality and ease of use.

Communicating design requirements (or simply the relevant design principles) before the tendering process may give the considered shipyards some indications of the shipping company's interests. As the process continues, you should make sure that the suppliers suggested by the shipyard can provide fair grounds for review, such as system or equipment demonstrations or references to ships where similar products have been installed, and where crewmembers can make real-life assessments.

It is important that contextual factors are not forgotten in the review, for example visibility, time of day, heavy seas or greasy hands. Experienced crewmembers are often good at coming up with varying conditions like these. Perhaps it is even possible to include in contracts that experienced (possibly handpicked) crewmembers should approve specific safety-critical systems.

LASH FIRE

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