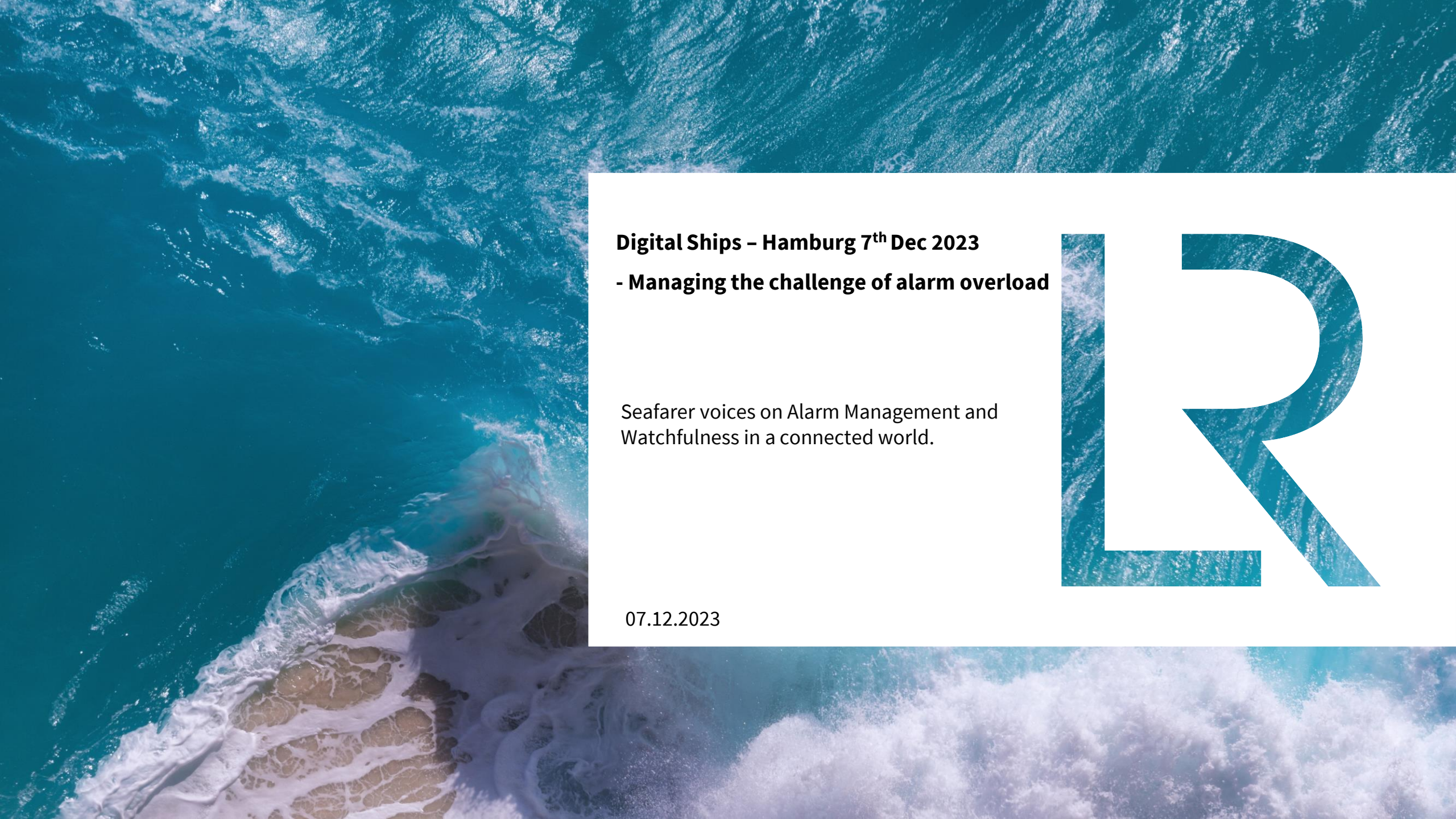


Digital Ships – Hamburg 7th Dec 2023

- Managing the challenge of alarm overload

Seafarer voices on Alarm Management and Watchfulness in a connected world.

07.12.2023

Agenda

1 **Are alarms the peril of maritime digitalisation and automation?**

2 Alarms 101 – and its cousins

3 What is the current (objective) state of affairs?

4 What does the seafarers say?

5 Limitations & Further research/work

1 // Are alarms the peril of maritime digitalisation and automation?

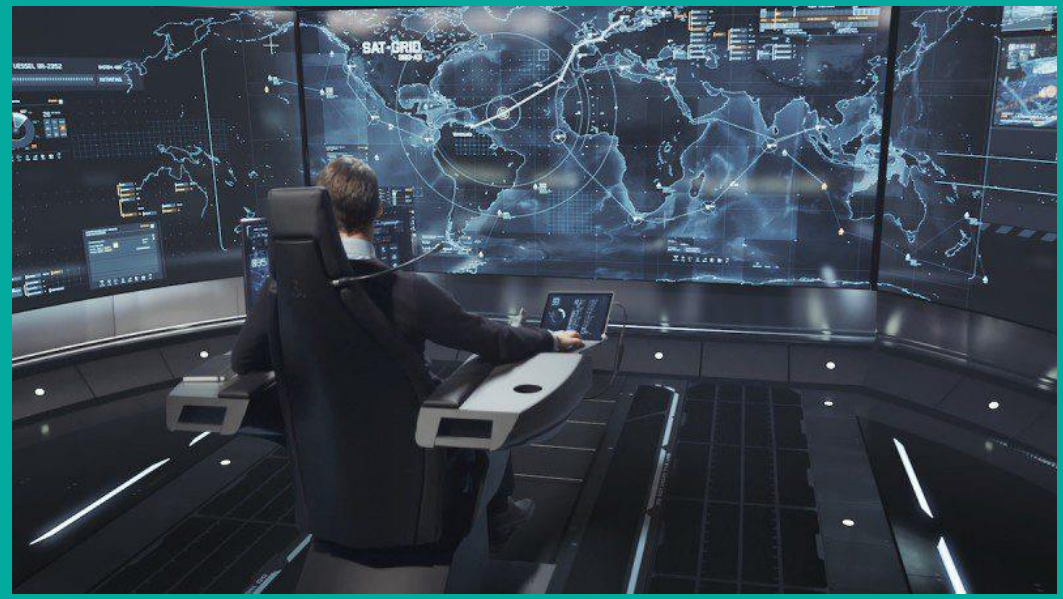
The maritime industry has bold ambitions for remote controlled, autonomous ships and other data intensive operations.

[25]

1 // Are alarms the peril of maritime digitalisation and automation?

The maritime industry has bold ambitions for remote controlled, autonomous ships and other data intensive operations.

This will require a reliable and predictable platform (ship).



[25]

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In the current situation do we believe a remote operator would feel like the person on the right picture?

[25]

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[5]

[25]

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1. Are alarms the peril of maritime digitalisation and automation?
2. **Alarms 101 – and its cousins**
3. What is the current (objective) state of affairs?
4. What does the seafarers say?
5. Limitations & Further research/work

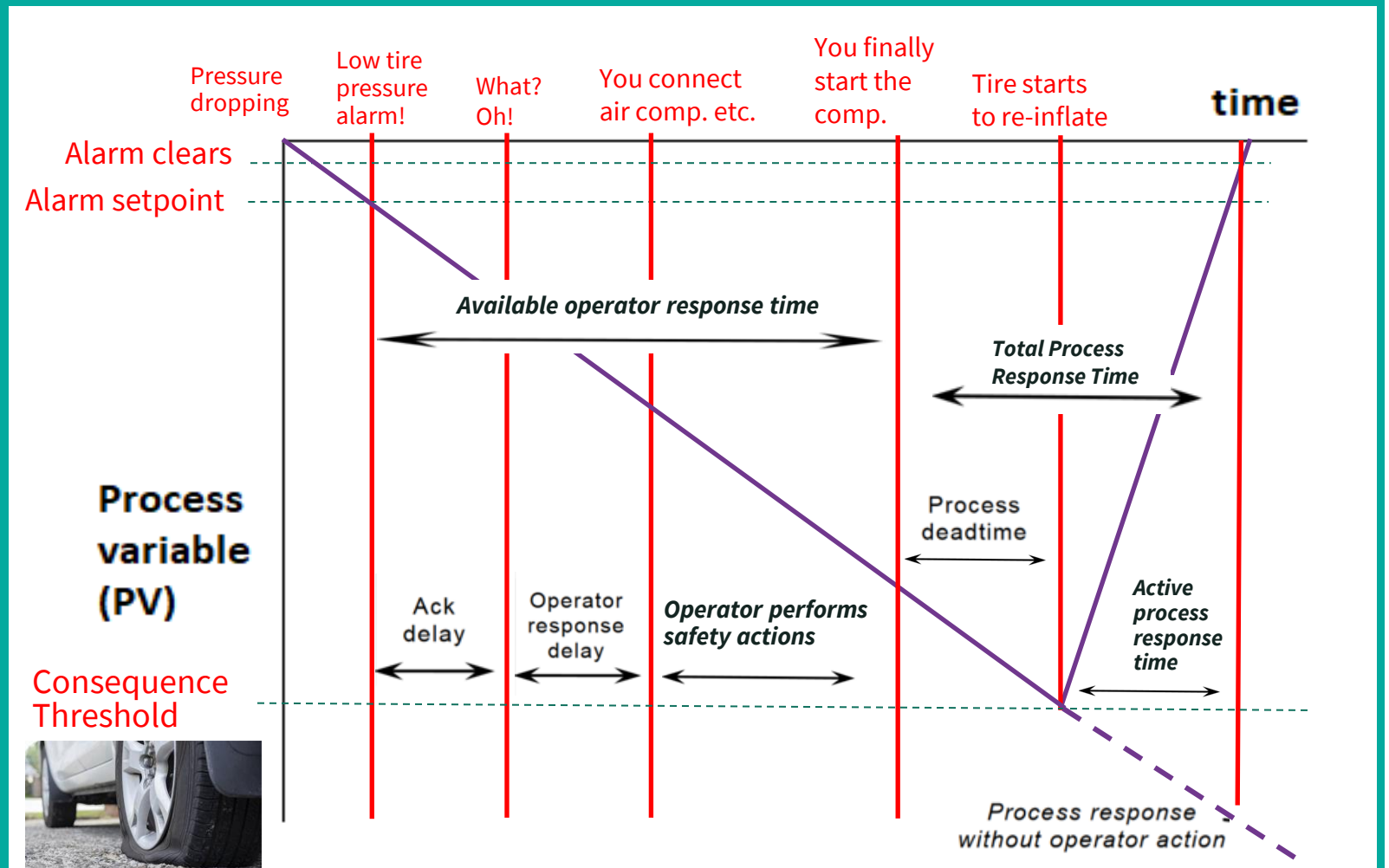
2 // Alarms 101 – and its cousins

Alarm definition - simple: Some communicated message to someone about something you don't want to happen – such that this someone will (hopefully) respond and intervene before it happens.

Alarm example: Tire pressure monitoring in your (modern) car

Why do I have this alarm? The hard truth? Someone decided to give up designing or engineering this problem away, so now you have to deal with it.

Or you could pay for run-flat tires? But would you?

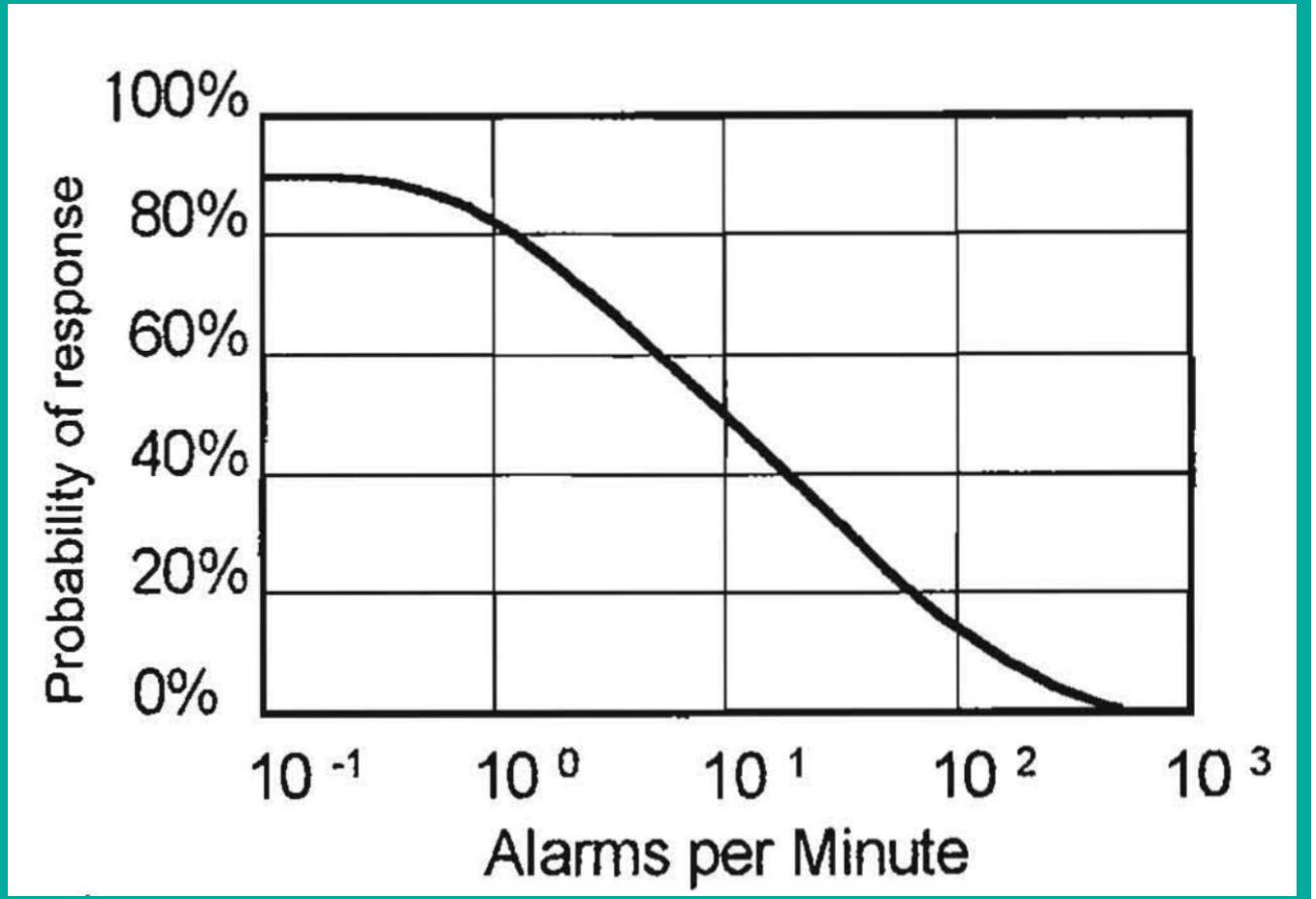


2 // Alarms 101 – and its cousins

How many alarms can a trained user deal with at the time?

It depends. But it's well understood that the probability of failing to respond to an alarm depends is affected by the alarm rate (and other factors) presented to the user, according to human factors experts.

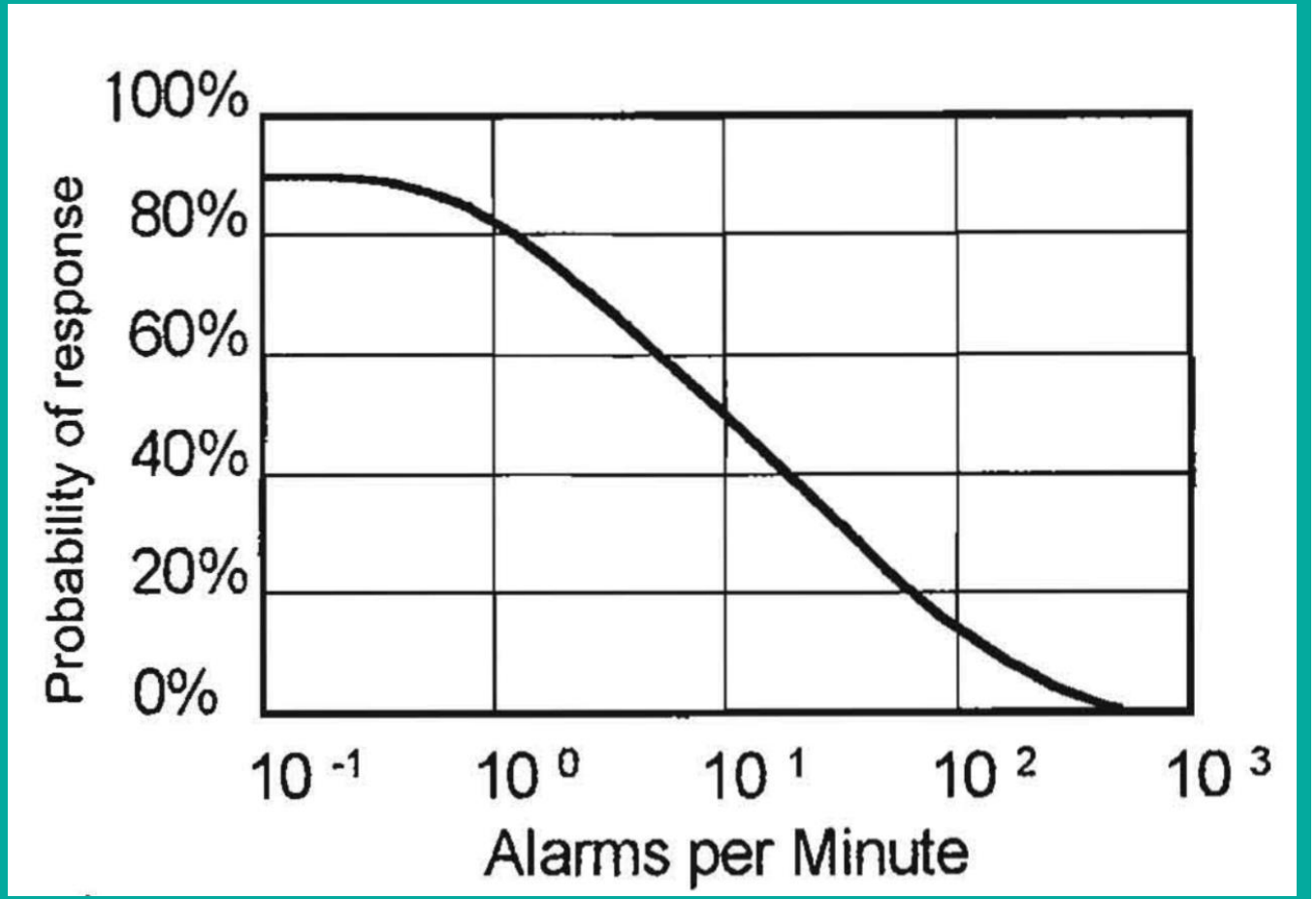
[9]



2 // Alarms 101 – and its cousins

How many alarms can a trained user deal with at the time?

What was the probability of response when there is one alarm a minute? (in 1990's with unique indicators/lamps for each alarm)



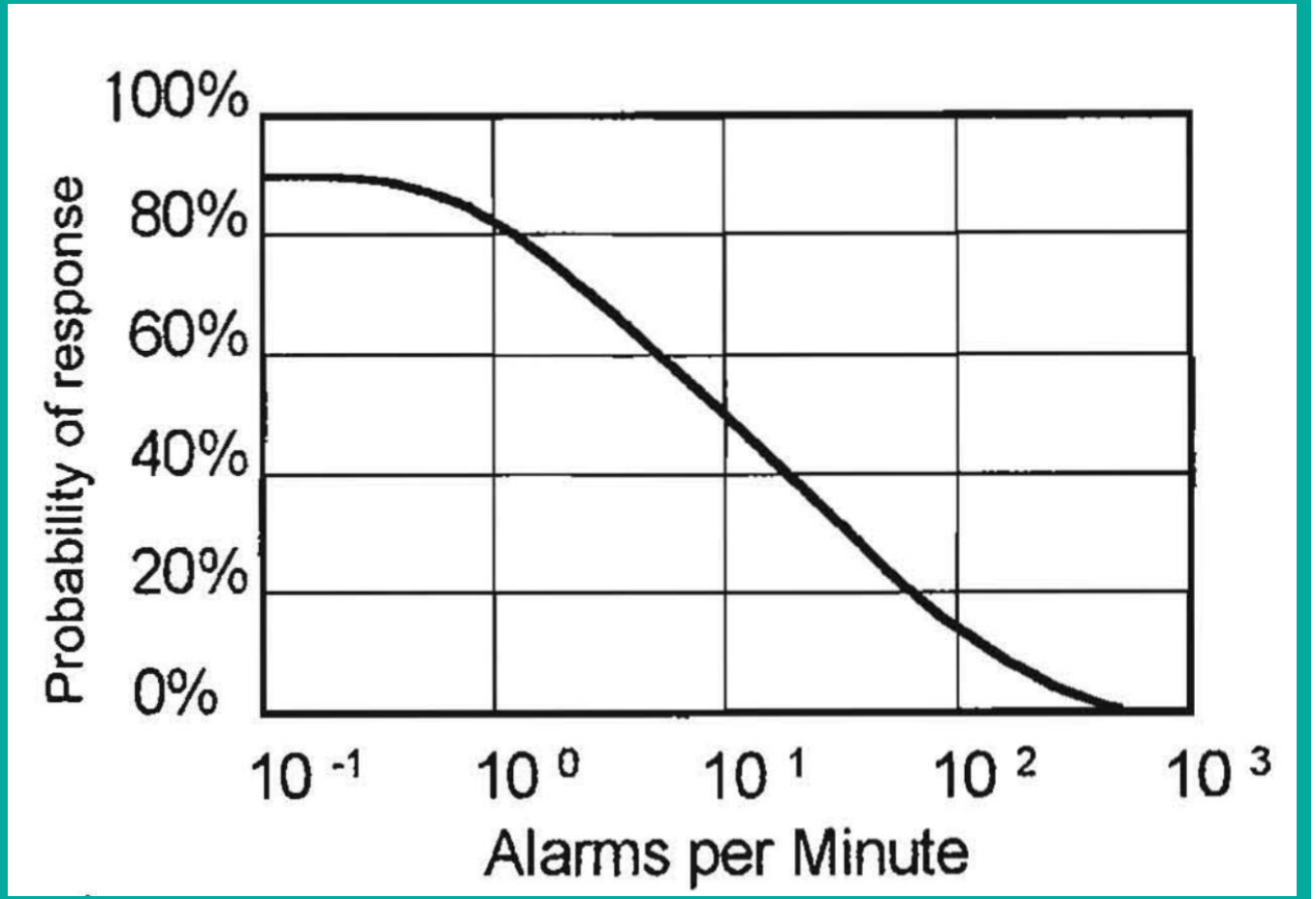
[9]

2 // Alarms 101 – and its cousins

So, what should define the performance criteria of a good alarm system?
A. The rate at which it can inform the user of abnormal situations?

OR

B. The rate at which the user can detect, diagnose, decide and respond to alarms?



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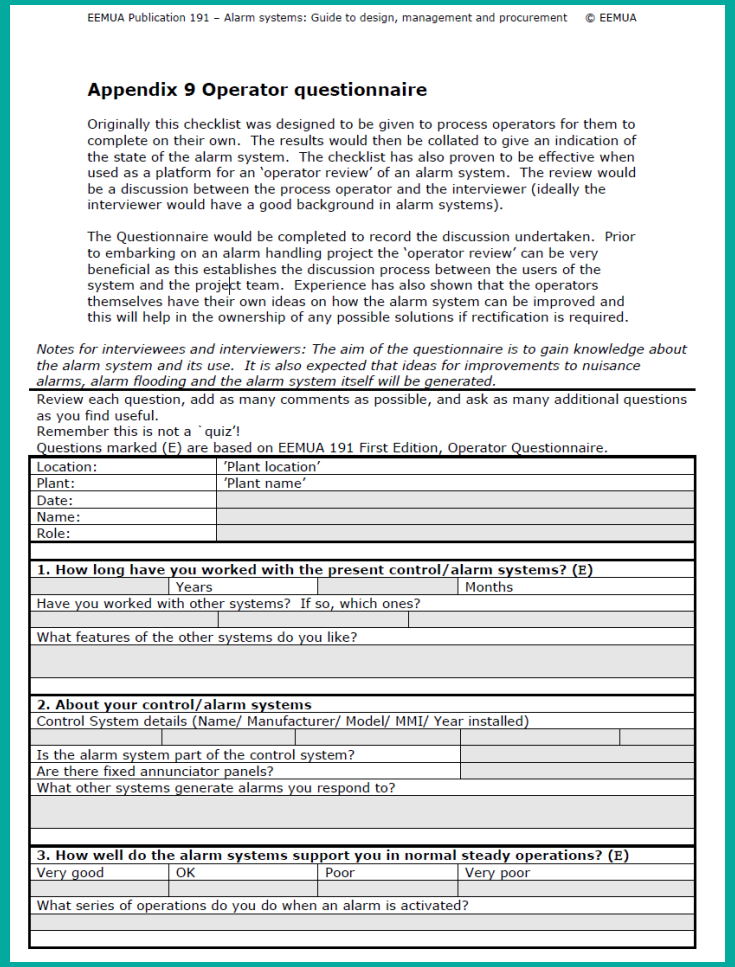
3 // What is the current (objective) state of affairs?

So, how do seafarers experience their alarm systems today (systems designed acc. Class Rules and Regulations)?

LR has in the last 4 months been interviewing approximately **65 watchkeeping seafarers** on their opinions on their alarm system's usability (ship adapted version of EEMUA 191 appendix 9 questions). **On approx. 16 different ships.**

This has only been possible through great collaboration with the ship operators. Thanks for inviting us onboard!



EEMUA Publication 191 – Alarm systems: Guide to design, management and procurement © EEMUA

Appendix 9 Operator questionnaire

Originally this checklist was designed to be given to process operators for them to complete on their own. The results would then be collated to give an indication of the state of the alarm system. The checklist has also proven to be effective when used as a platform for an 'operator review' of an alarm system. The review would be a discussion between the process operator and the interviewer (ideally the interviewer would have a good background in alarm systems).

The Questionnaire would be completed to record the discussion undertaken. Prior to embarking on an alarm handling project the 'operator review' can be very beneficial as this establishes the discussion process between the users of the system and the project team. Experience has also shown that the operators themselves have their own ideas on how the alarm system can be improved and this will help in the ownership of any possible solutions if rectification is required.

Notes for interviewees and interviewers: The aim of the questionnaire is to gain knowledge about the alarm system and its use. It is also expected that ideas for improvements to nuisance alarms, alarm flooding and the alarm system itself will be generated.

Review each question, add as many comments as possible, and ask as many additional questions as you find useful.
Remember this is not a `quiz'!
Questions marked (E) are based on EEMUA 191 First Edition, Operator Questionnaire.

Location:	'Plant location'
Plant:	'Plant name'
Date:	
Name:	
Role:	

1. How long have you worked with the present control/alarm systems? (E)

	Years		Months

Have you worked with other systems? If so, which ones?

What features of the other systems do you like?

2. About your control/alarm systems

Control System details (Name/ Manufacturer/ Model/ MMI/ Year installed)

Is the alarm system part of the control system?	
Are there fixed annunciator panels?	

What other systems generate alarms you respond to?

3. How well do the alarm systems support you in normal steady operations? (E)

Very good	OK	Poor	Very poor

What series of operations do you do when an alarm is activated?

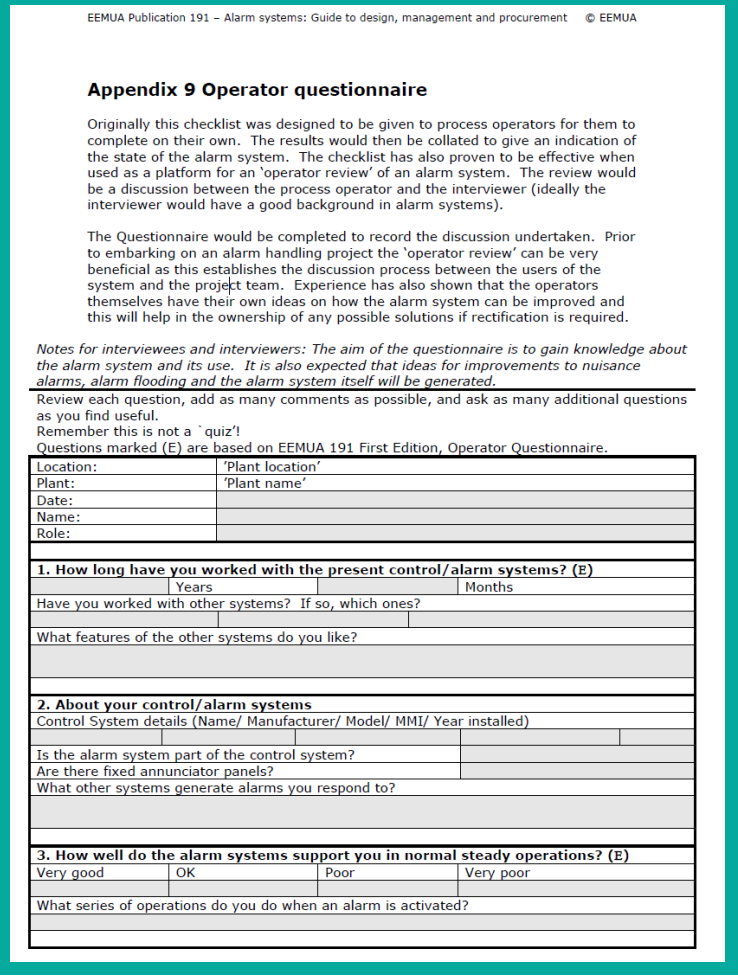
[8]

3 // What is the current (objective) state of affairs?

So, how do seafarers experience their alarm systems today (systems designed acc. Class Rules and Regulations)?

Short details about collected data:

- Multiple ship segments are represented, of various ages and other “ship demographics”.
- All ranges of rank and experience from
  - Cadets to Captains
  - Junior to Chief Engineers



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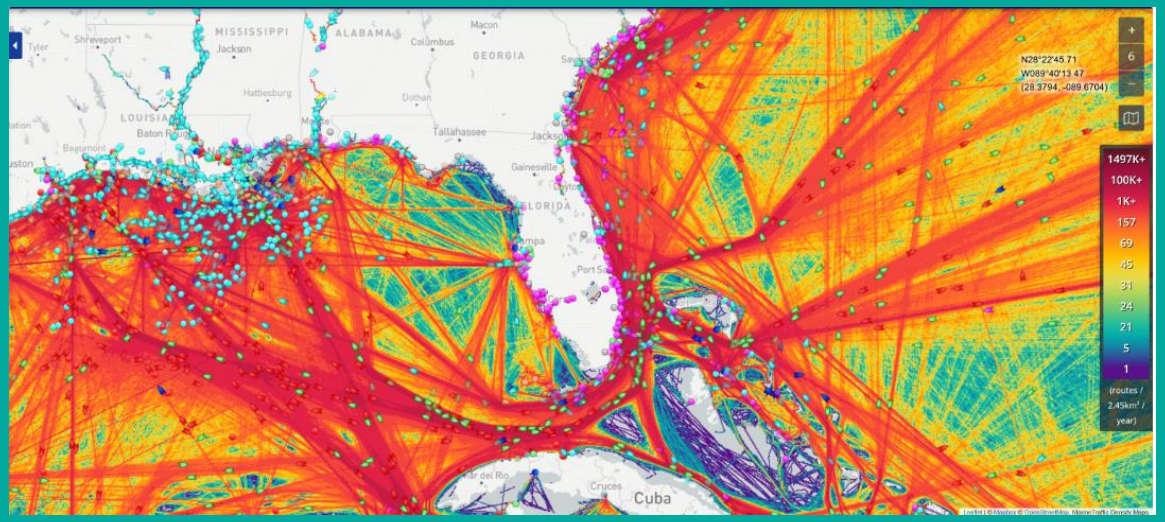
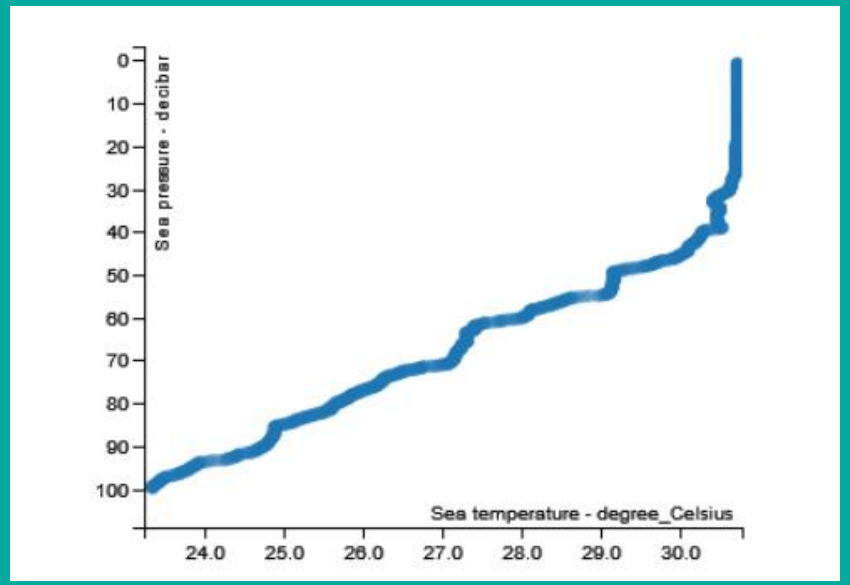
3 // What is the current (objective) state of affairs?

So, how do seafarers experience their alarm systems today (systems designed acc. Class Rules and Regulations)?

In addition, LR received logs of the alarms/events that these people experience. In total, more than 10 years of data. It includes also Spatial (position, heading etc.) and Weather data.



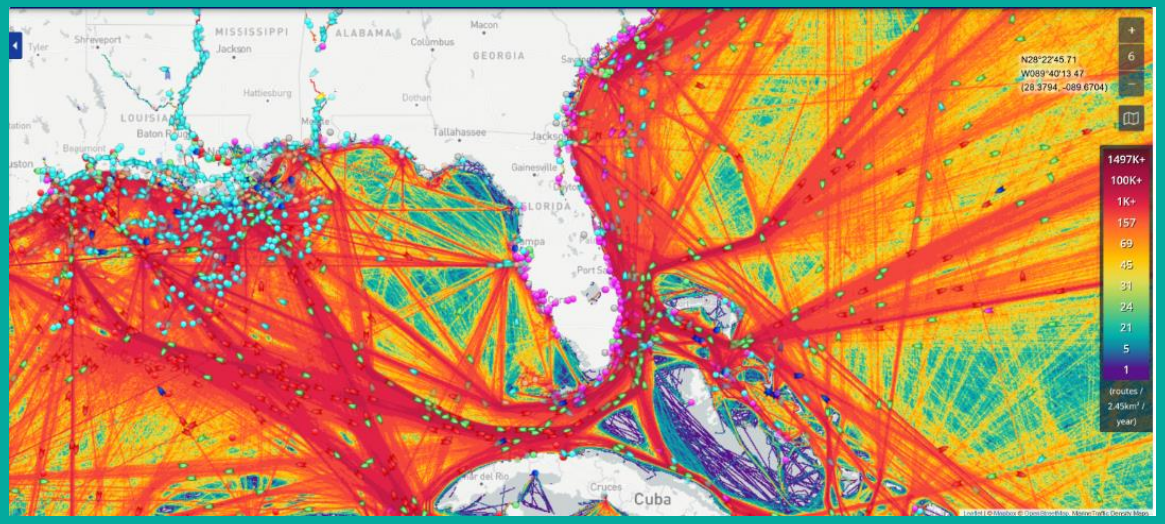


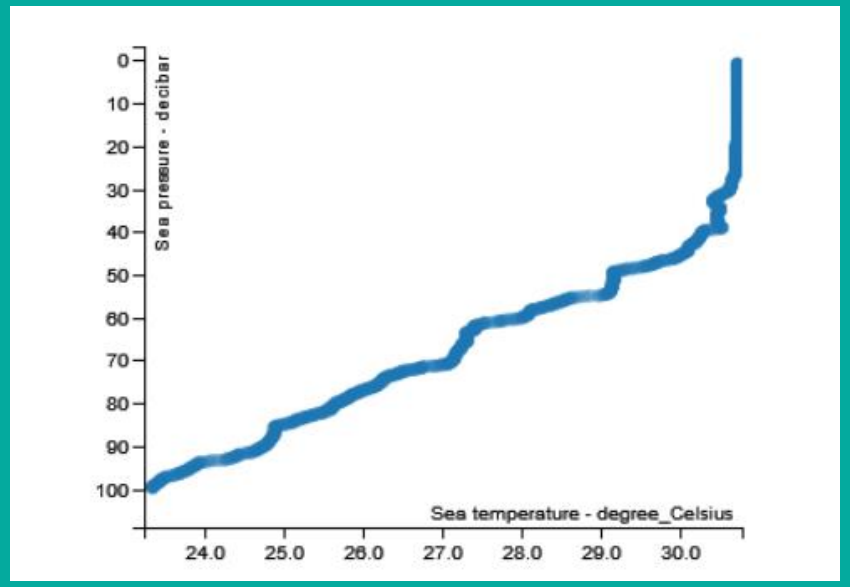
3 // What is the current (objective) state of affairs?

So, how do seafarers experience their alarm systems today (systems designed acc. Class Rules and Regulations)?

Its amazing what you can get data on today, even cooling (sea temperatures down to 100 decibar (approx. 100m) depths) is available. Provided one knows where to look.

Its worth mentioning that the “expensive” data is the opinion of the seafarers - getting onboard todays vessels is not easy.

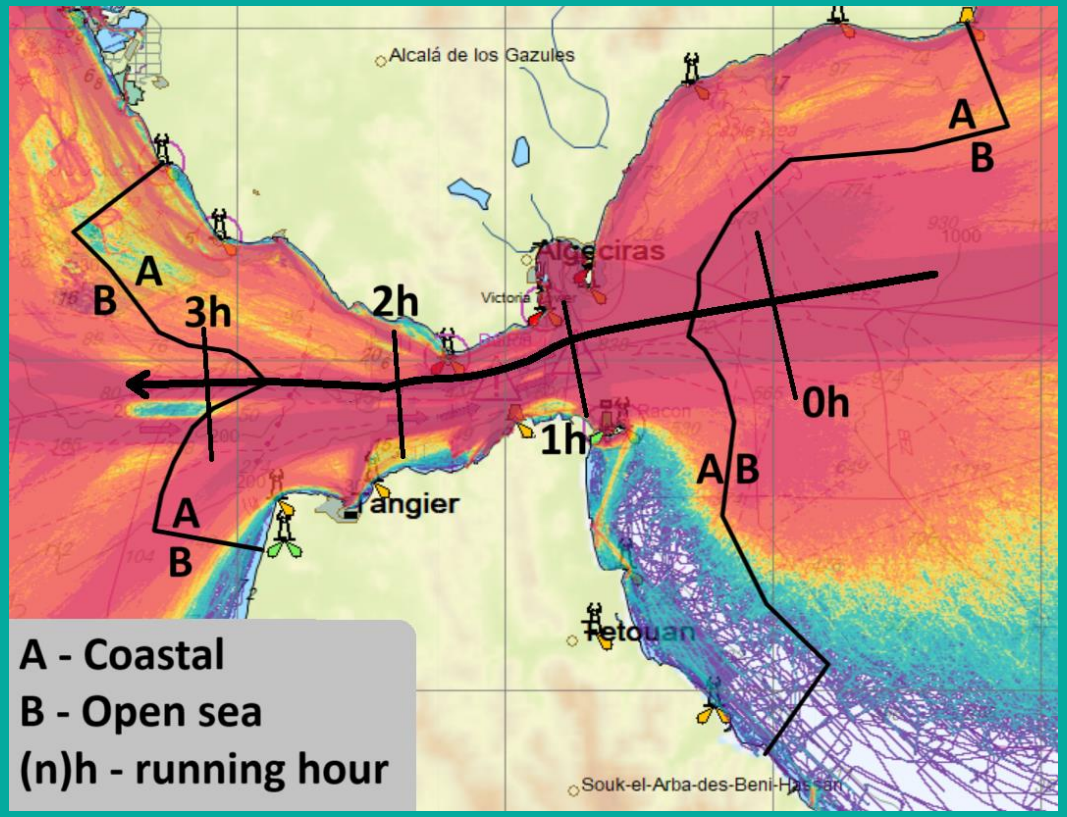


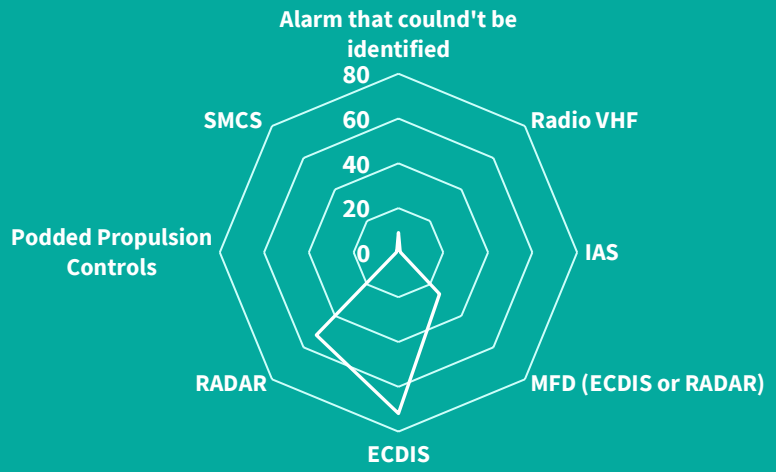


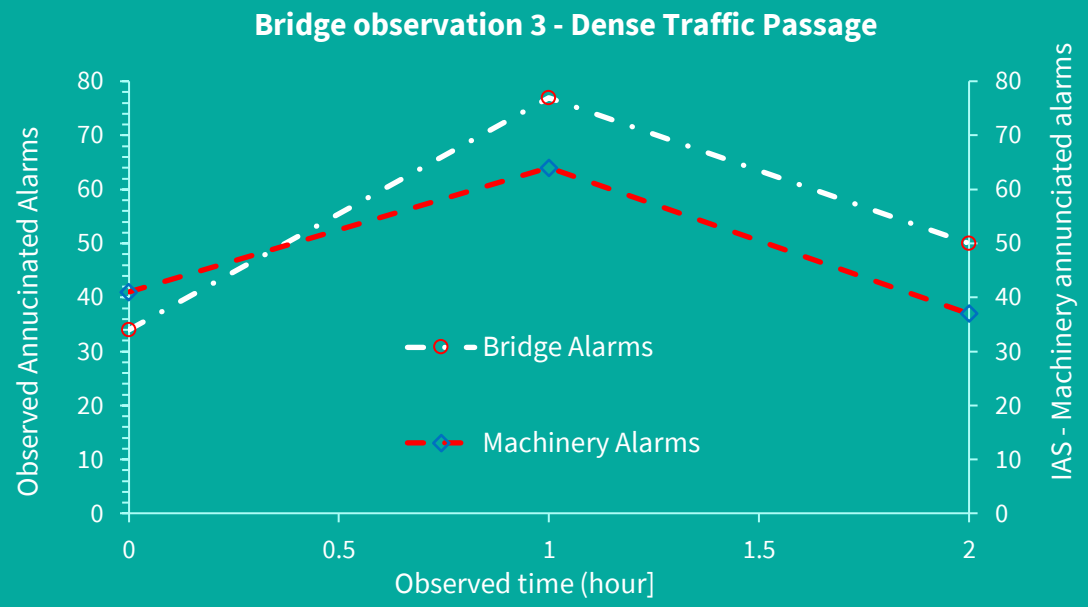
3 // What is the current (objective) state of affairs?

The data also includes outer operational envelopes:
Situations where we expect many alarms.

Such as on the bridge through the strait of Gibraltar.





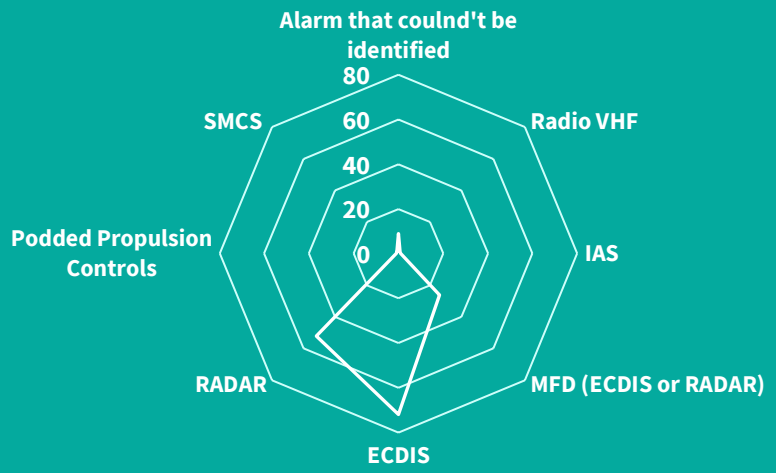


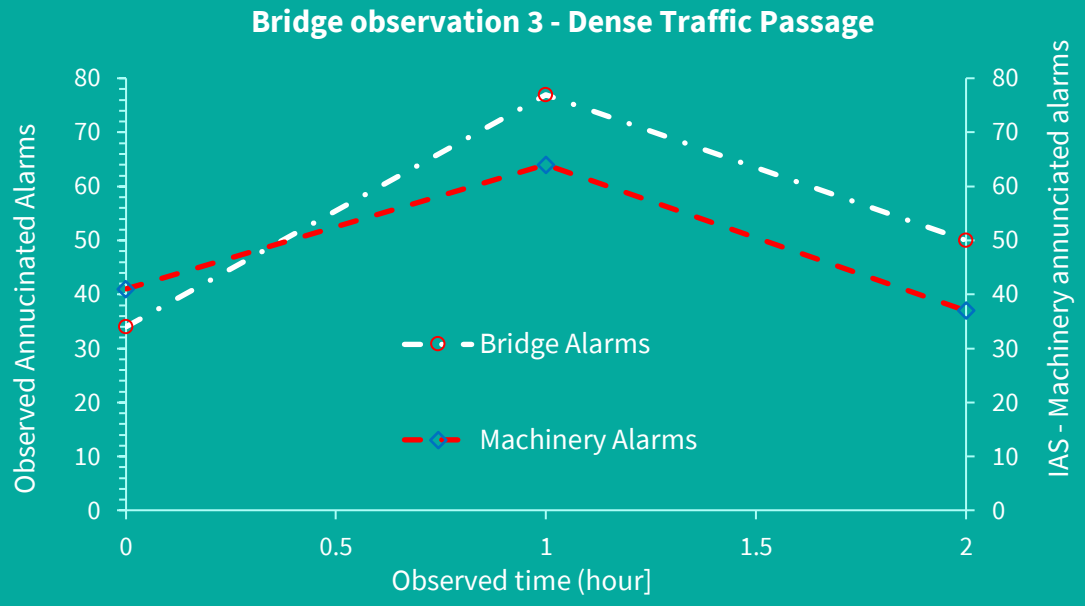
3 // What is the current (objective) state of affairs?

approx. a three-hour period. Which showed 163 alarms (for the first ship).

In the same time period, 2h 48 minutes, there were 144 annunciated alarms in the **ECR**

	A	B	C	D	E	F	G	H	I	J	K	L
1		Time	Alarm	Alarm that coulnd't be identified	Radio VHF (Sailor)	IAS (Operator Station 32)	MFD1 (ECDIS or RADAR)	ECDIS (MFD 1)	RADAR (MFD 1)	Portside Podded Propulsion Controls (Siemens)	SMCS (Operator Station 61)	
143		02:31:59	Crossing area - Traffic separation					1				
144		02:33:06	Crossing area - Traffic separation					1				
145		02:34:02	?				1					
146		02:34:59	VDR Missing - Failed to send a message to a VDR				1					
160		02:39:59	Crossing area					1				
162		02:40:04	Approaching WPT Early					1				
165		02:43:03	DPTH Failure						1			
166		02:48:34	END of DATA COLLECTION									
167			SUM each column	9	1	1	26	72	52	1	1	
168			SUM TOTAL									163
169												





3 // What is the current (objective) state of affairs?

How do you think a officers “navigate” in an environment where they must acknowledge an alarm approx. every minute for multiple hours straight? (While navigating highly trafficked waters)

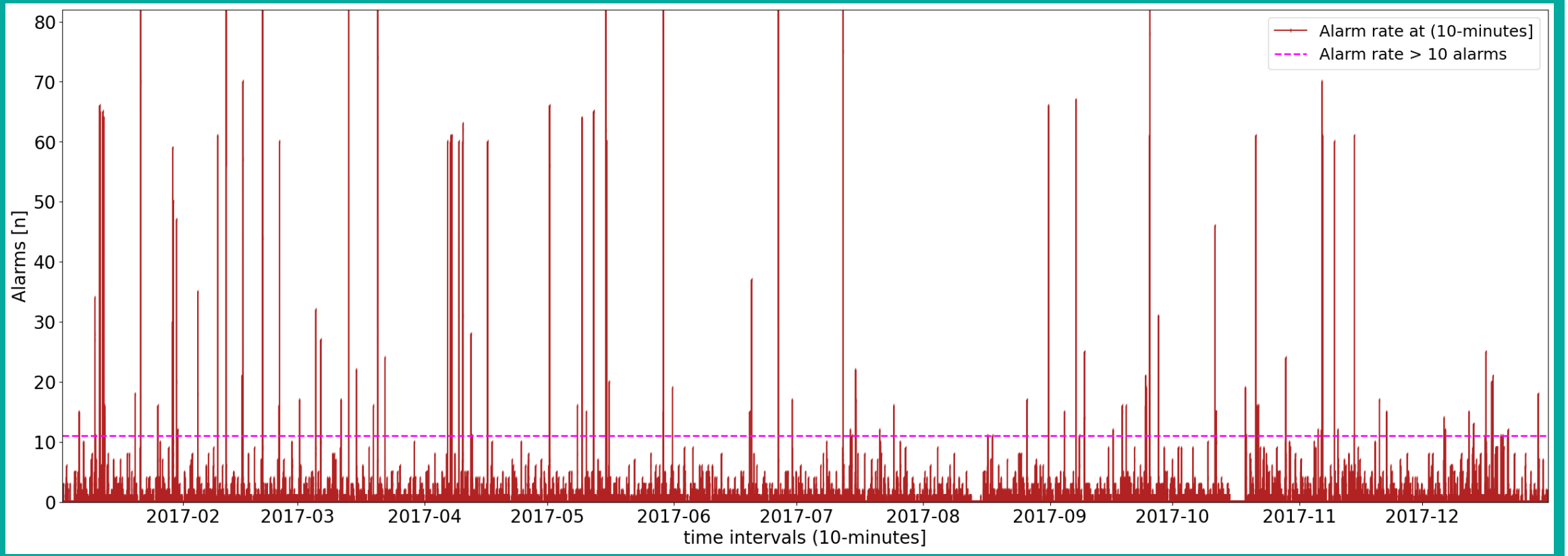
They get the tapes out.

[14]

3 // What is the current (objective) state of affairs?

Alarm floods – a real phenomenon, only for new and complex vessels?

IN THE ECR: One of the sampled Ship's (built in the early 2000's) experienced 218 alarm floods a year in 2017*.
Notice how the bar (y-axis) had to be cut at 80 alarms to not drown the threshold – the top it? Close to 400.



*IEC 62682 – Alarm flood:
Begins: when there is more than 10 alarms in a regular 10 min interval.
Seizes: when the rate falls below 5 alarms in a regular 10 min interval.

3 // What is the current (objective) state of affairs?

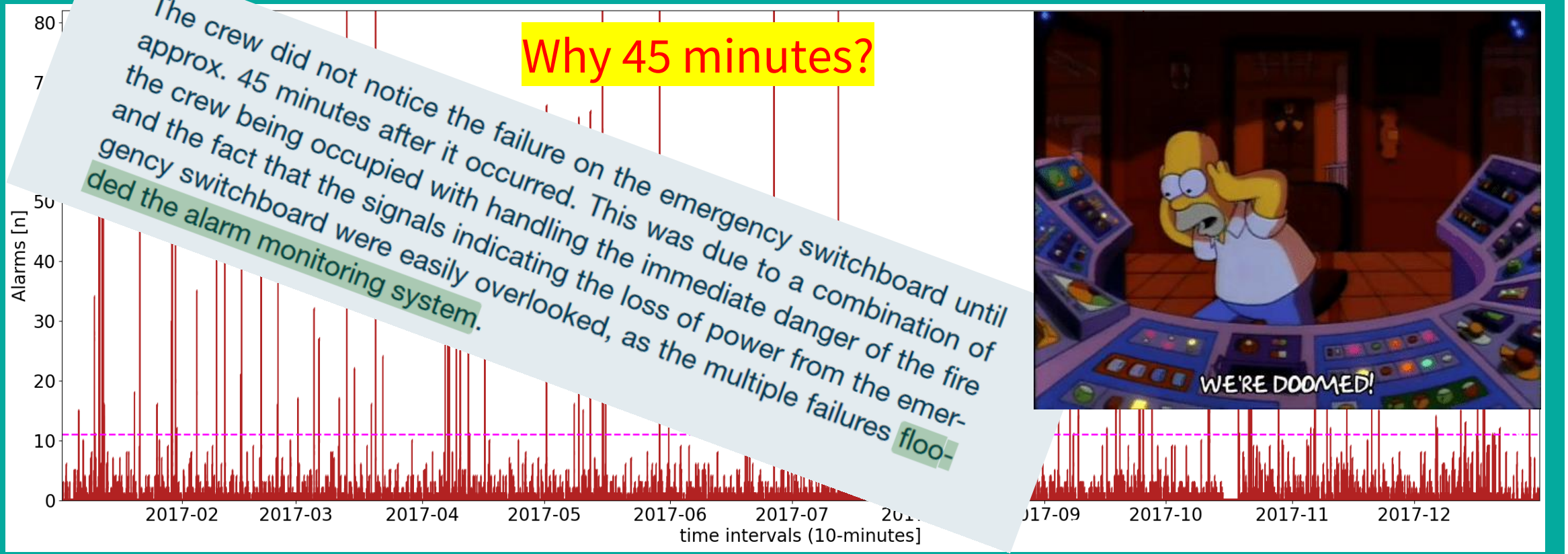
Does events happen where alarm floods become a problem in maritime?

In the investigation report on the Stena Scandica (built 2005) incident DMAIB (Danish Maritime Accident Investigation Board) stated [19]:

- The crew did not notice the failure on the emergency switchboard until approx. 45 minutes after it occurred. This was due to a combination of the crew being occupied with handling the immediate danger of the fire and the fact that the signals indicating the loss of power from the emergency switchboard were easily overlooked, as the multiple failures flooded the alarm monitoring system.

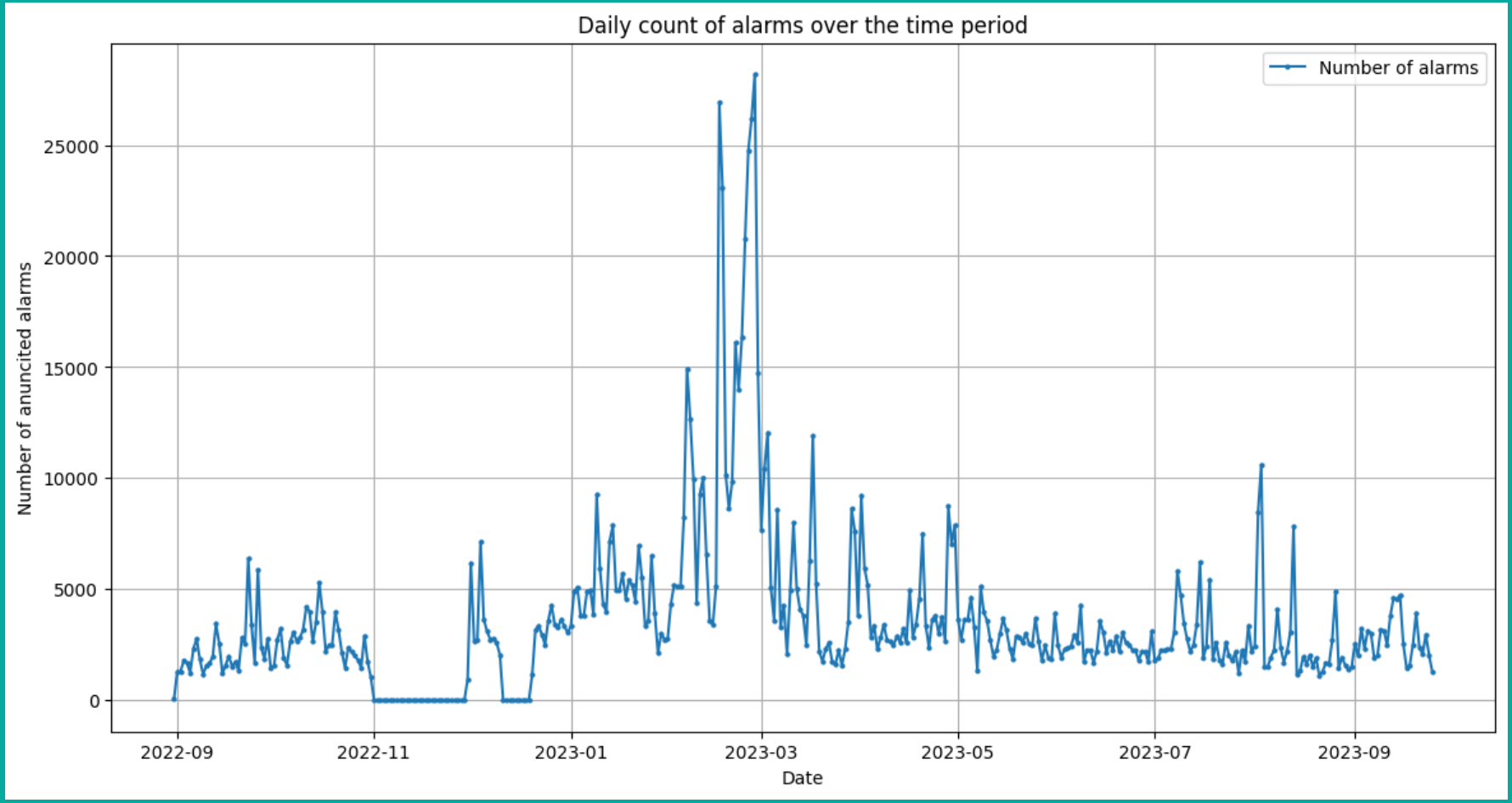
Why 45 minutes?

How do users experience alarm floods? [5]



3 // What is the current (objective) state of affairs?

What about a ship which is only a few years old?



How about 25.000 alarms on a bad day? - in the ECR

Or just a few thousand on a good one?

[21]

3 // What is the current (objective) state of affairs?

Alarm fatigue – a real phenomenon in maritime?

What would you do if you got a false phone call on your mobile every 60 seconds?

What do you think humans do in an operational context?

[14]

3 // What is the current (objective) state of affairs?

Alarm fatigue – a real phenomenon?

Do you see the alarm list on any of the six large displays available in the ECR?

[14]

3 // What is the current (objective) state of affairs?

Alarm fatigue – a real phenomenon?

Do you see the alarm list on any of the six large displays available in the ECR?

Can we claim usability of anything which we observe not being used at all?

[14]

3 // What is the current (objective) state of affairs?

Alarm fatigue – a real phenomenon?

It would look like ->

Usable?

[5]

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5. Limitations & Further research/work

4 // What does the seafarers say?

Extracts of the voices of the watchkeepers (Navigators and Engineers):

WE SIMPLY GET TOO MANY ALARMS, IT'S RIDICULOUS!

'Crossing area' alarms - Honestly... they bring no value

It's the same sound for each alarm

Any change is an improvement!

You get so many alarms during a watch that you become numb to the alarms

What do you like the least? – All the alarms

There's no prioritisation of the alarms

What do you like the least? – The volume of the alarms

Young officers don't know better, they think this is how it's supposed to be

I've never known so many alarms as we got here

There's no way to take all the alarms in during a blackout!

Young engineers have to evolve with alarm system

The alarm sound is sooo loud that you can't think

In demanding operations, we have one officer dedicated to the muting of alarms

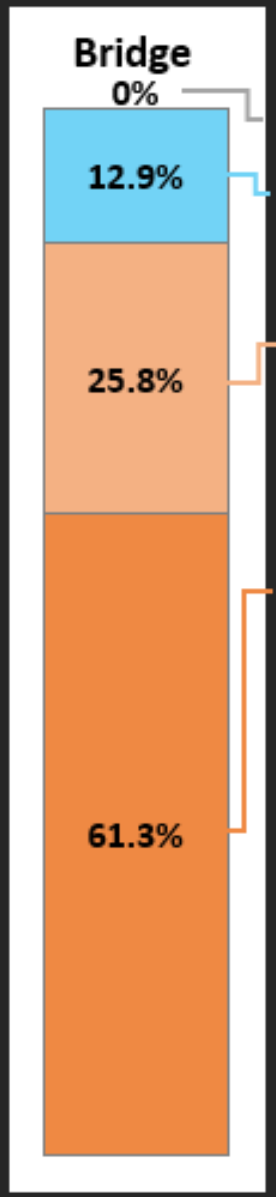
We need **ONE** fully integrated system!

4 // What does the seafarers say?

Some extracts of the opinions

61% of the bridge officers believe there is too many alarms provisioned onboard their ship

Some said they need a new position onboard: … Alarm Officer…



Question 5: What about the number of alarms in the system?

Too few: No respondents

Few but adequate

5.1B - The settings (in the ECDIS) can be adjusted to a minimum.

Many but necessary

5.2B - The alarms are there for a reason. Most of them can provide very valuable information.

Too many

5.3B - "70-80% of the alarms we don't need".
5.4B - "We need to get rid of some alarms".
5.5B - "We need filtering of the alarms, so we don't get the unimportant ones".
5.6B - "We should have a new position as 'Alarm Officers'".
5.7B - "Sometimes the alarm 'tank level gauge' sounds for 5 hours straight"
- "Literally it is constantly annunciated. You have to dedicate one guy to silence it".

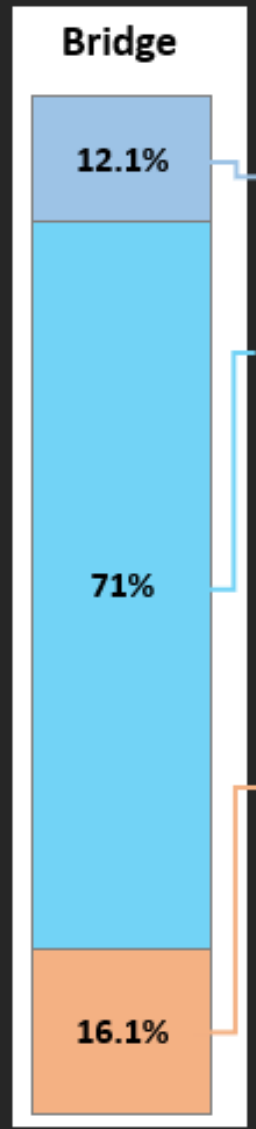
4 // What does the seafarers say?

Some extracts of the opinions

Only 12% always know what to do for the alarms in the systems

For some bridge officers the machinery alarms make very little sense and a cause of distraction.

One stated “Everything means “call the plumber” for me”



Question 10: Do you fully understand each alarm message and know what to do about it?

Always

10.1B The officer has been sailing on this ship for years and knows, from what he says, every alarm.

Mostly

10.2B “Sometimes you get alarms from a panel that you don’t know what it means, but when you look in the manual there are no description for that alarm… this is rare, but it has happened a couple of times.”

10.3B “I consider engine room alarms more as a distraction than a help to me”.

10.4B It sometimes happens that the officer receives ‘Unspecified’ alarms in the IAS.

Sometimes

10.5B For a few months in a row the officers received the alarm ‘call plumber’ through the IAS system. – They have no idea what it meant.

When talking about the IAS system: “Everything means ‘call the plumber’ for me”.

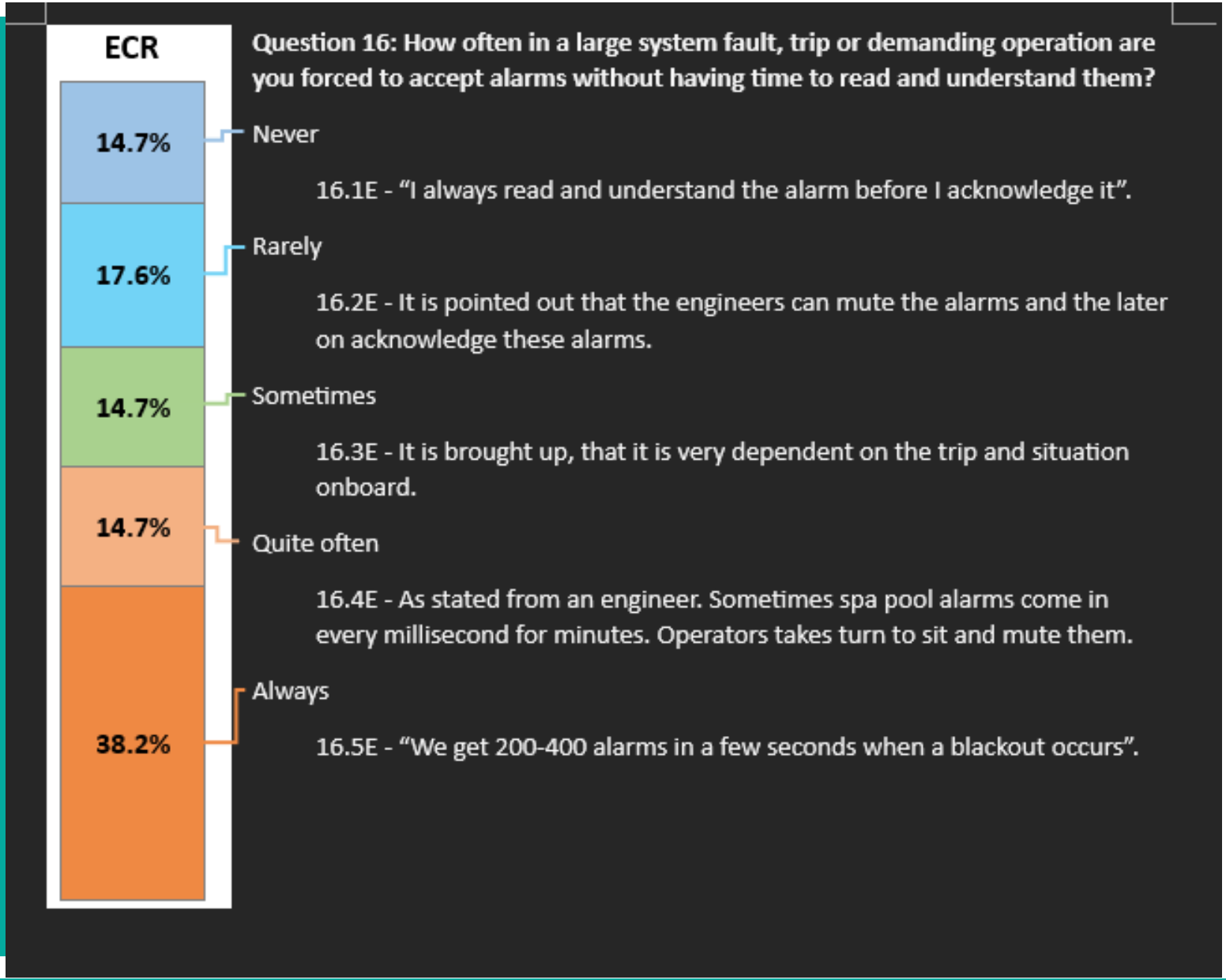
10.6B Alarm descriptions on propulsion are vague, and the officers don’t know what they mean.

4 // What does the seafarers say?

Some extracts of the opinions

In abnormal situations, 38% of the Engineering watchkeepers state they feel forced to accept alarms without time to read and understand them.

On one ship, the officers need to take turns to simply sit and mute the alarms as they come in every millisecond.

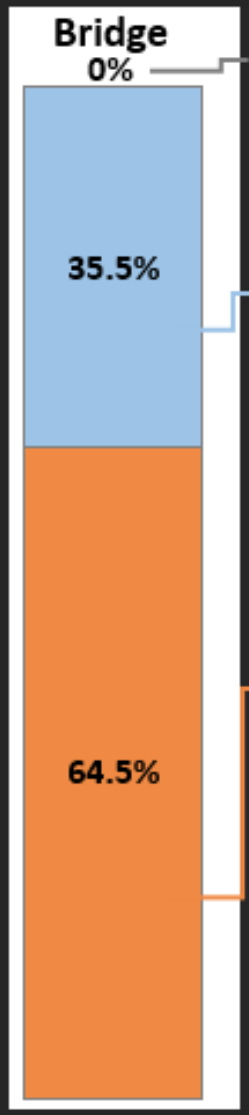


4 // What does the seafarers say?

Extracts of the

Roughly 35% of the Bride officers state that management effort is about right in improving the alarm systems

Almost 65% of the Bridge Officers hope that management will pay more attention to their experience of the alarm systems



Question 19: Compared with the other things your management does to improve your operations, such as adding additional technology, do they put enough effort into improving the alarm systems?

Too much

No answer

About right

19.1B - An officer explained that the shore management are willing to spend money to improve the systems and well-being of the officers.

19.2B - "If we reach out, yes, otherwise no".

Too little

19.3B - "They don't do anything for us regarding the alarms! They just don't, so they can blame us when it goes wrong!"

19.4B - "We need people ashore that knows how the ship works and what things help and don't!"

19.5B - The officer states that he/she would like the management from the shipping company to ask the operators about their experience with the alarm systems.

19.6B - "If the management care about the safety of the ship, they have to do improvements to the alarm system".

19.7B - The officers have the reoccurring nuisance alarms 'DPTH Failure" and 'VDR Missing', that has been occurring since manufacturing.

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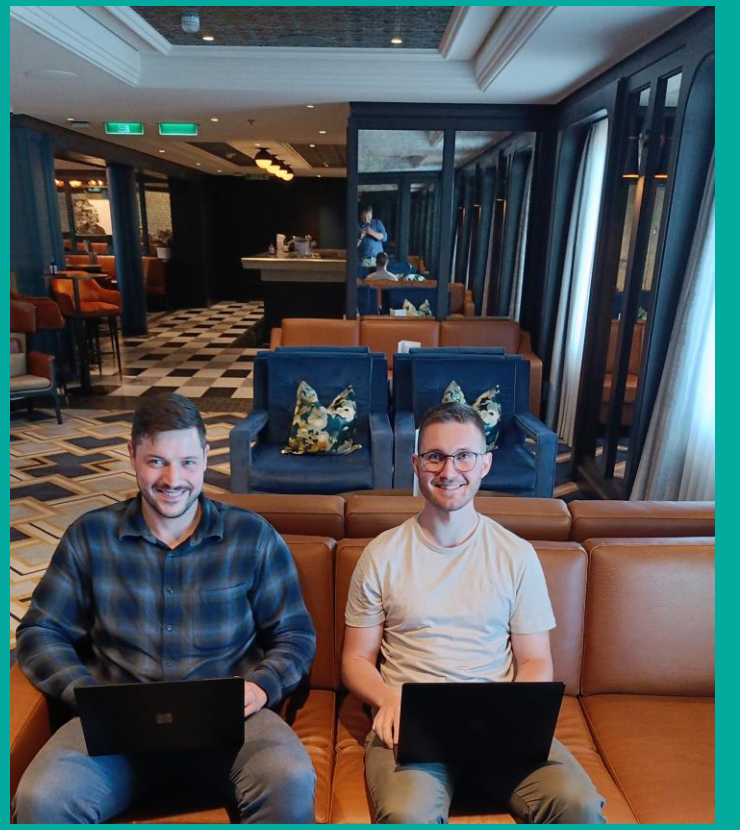
5 // Limitations & Further research/work

Who have collected and analysed the data over the last few months?

Two graduate students, Magnus(left) and Mark(right)
(Maskinmestre/Marine Engineers).

[14]



5 // Limitations & Further research/work

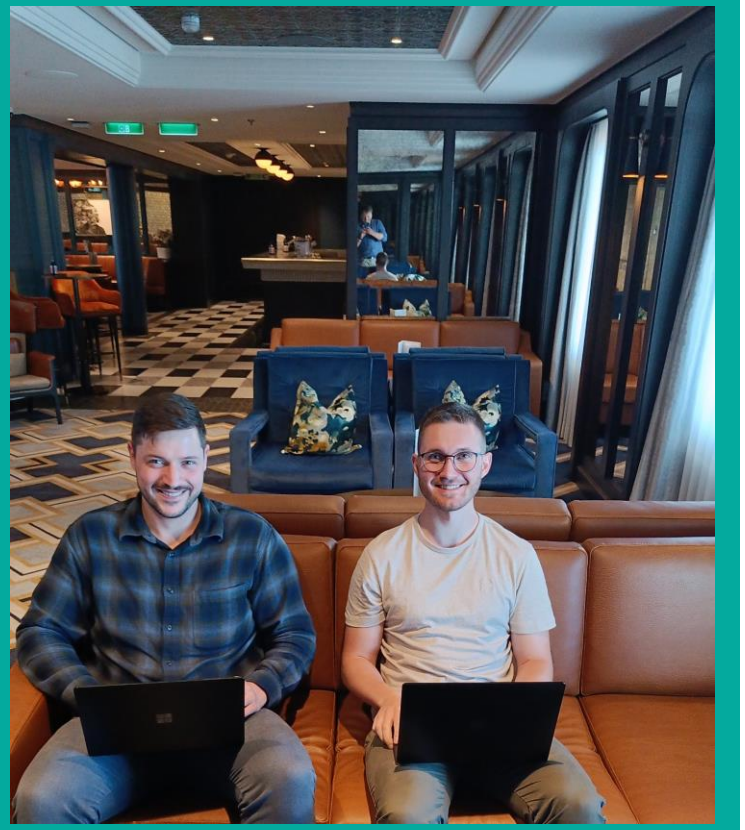
Who have collected and analysed the data over the last few months?

Two graduate students, Magnus(left) and Mark(right)
(Maskinmestre/Marine Engineers).

Sums up their experience:

"Its amazing to have direct access to more than 3,000 experts in almost any field of engineering. Not only do you assist LR in making the world safer place, but you do so from the user's perspective, at the front line, where it ultimately matters" – *Magnus*

[14]



5 // Limitations & Further research/work

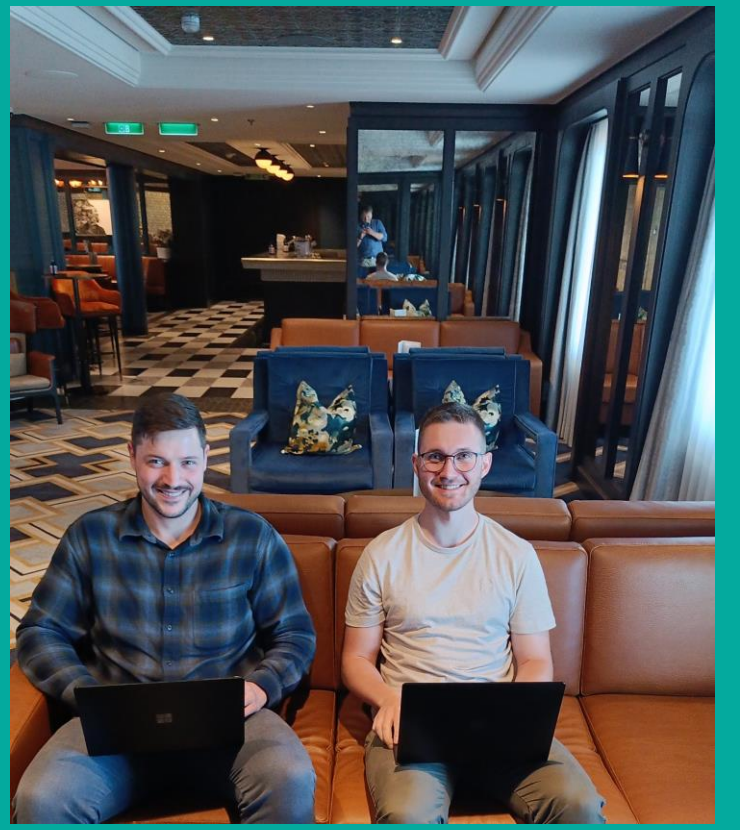
Who have collected and analysed the data over the last few months?

Two graduate students, Magnus(left) and Mark(right)
(Maskinmestre/Marine Engineers).

Sums up their experience:

"Its amazing to have direct access to more than 3,000 experts in almost any field of engineering. Not only do you assist LR in making the world safer place, but you do so from the user's perspective, at the front line, where it ultimately matters" – *Magnus*

"Its crazy when you imagine that we could be the people in the same shoes as the watchkeepers after graduating. It really gives a purpose to hopefully help improve this situation"- *Mark*



[14]

5 // Limitations & Further research/work

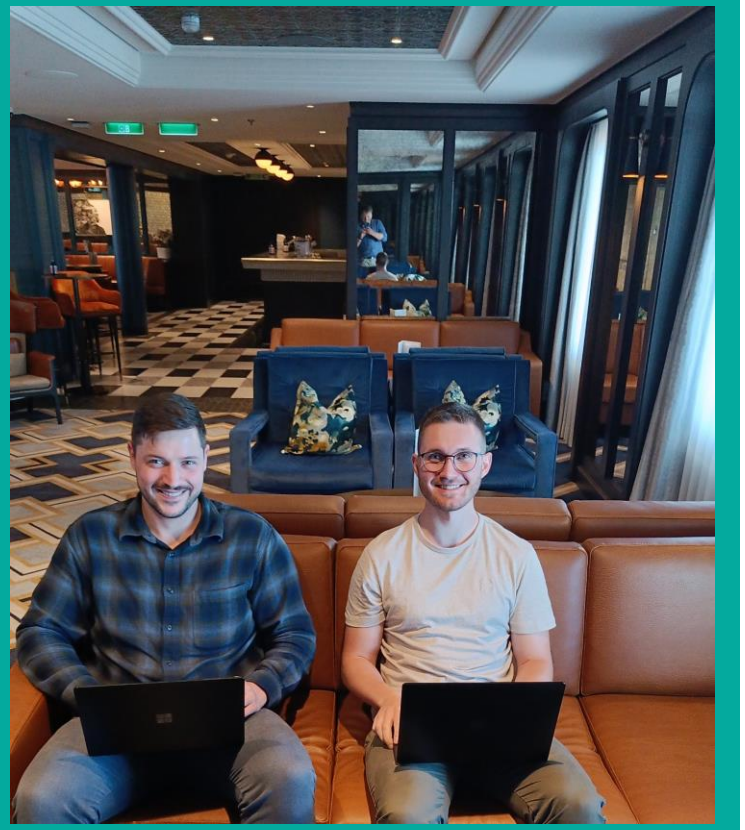
We share, we care, we do the right thing.

Their report and the dataset will be made open-source and the work in progress can be followed here: https://deepnote.com/@alarm-management/Alarm-Management-4fc1b659-ac27-46a0-b7af-56e052b70264

Open source!?!

Extensive data engineering was done prior to collecting the data. Anonymised (yet rich) data holds great potential. Without creating liability and blame, it can shine light on important systemic challenges and solutions.

[14]



5 // Limitations & Further research/work

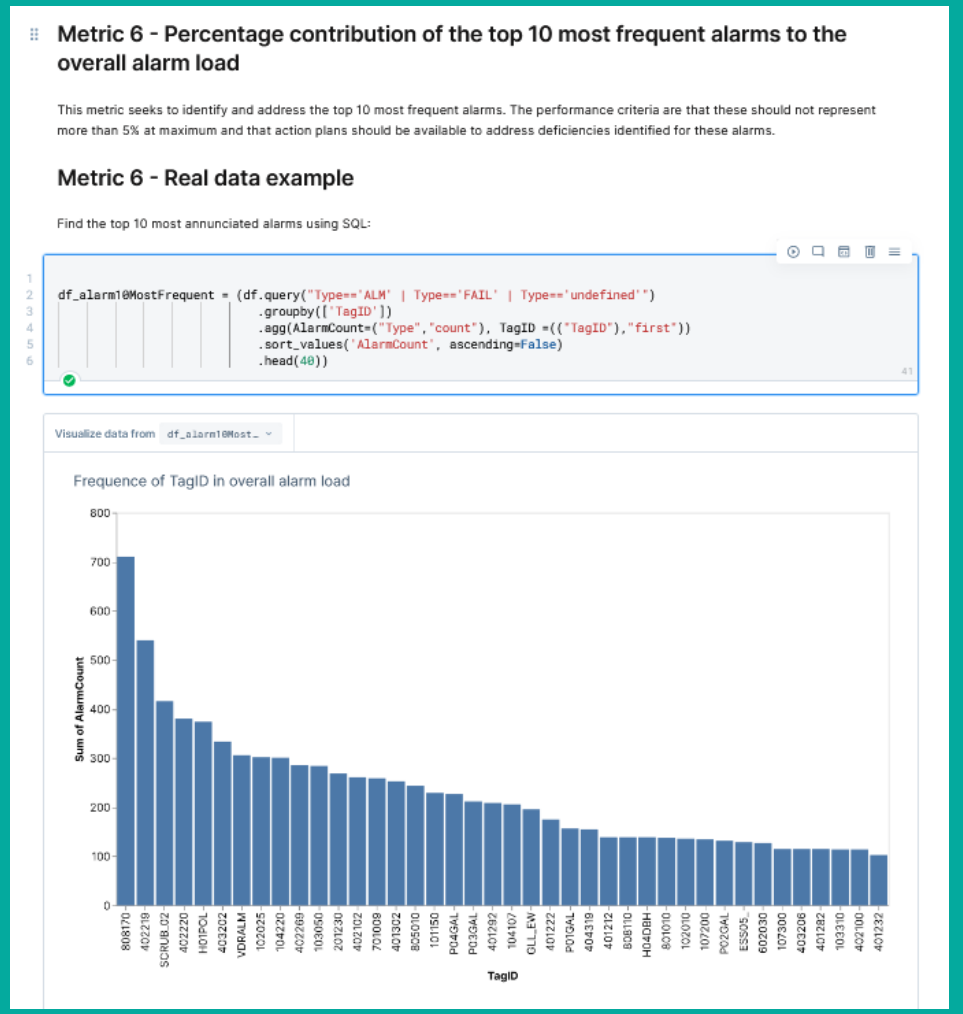
Didnt get your question answered?

It is likely that your question could not be addressed in this 20 min presentation. Such is normal.

If you want to hear more feel free to reach out.

Again stay tuned here – it may be that you find answers: https://deepnote.com/@alarm-management/Alarm-Management-4fc1b659-ac27-46a0-b7af-56e052b70264

Remember at LR, We share and we care?
-Therfore, all source code is made available, so industry (you) can use these methodologies in-house, should you have the capabilities to do so.



Thank you

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Email: Asger.schliemannhaug@lr.org ,Duncan.duffy@lr.org

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