

Investigating for Fatigue

Fatigue is never the root cause of a casualty, but it can often play a key role. However, it is not always easy to pinpoint in the course of an investigation. What should an investigator look for, and how?



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Fatigue has long been cited as a contributing factor for casualties, and for good reason. Time and time again, in a wide cross-section of industries, fatigue has been shown to have contributed to undesirable outcomes. But fatigue, in and of itself, is not the root cause of a casualty. Fatigue degrades human performance thus contributing to the chain of significant events that precede (and sometimes follow) a casualty. If fatigue is considered to have played a role in the casualty, there will always be at least one more 'why' to discover, such as: why was that person fatigued? Factors such as work schedule, personal sleep hygiene, ambient conditions (noise, comfort, light levels), or even sleep pathologies can be part of the answer to why fatigue was present. Another root cause to dig for would be: why was this person working while fatigued? Such factors as manning levels or less than adequate fatigue awareness may be at the root of this underlying condition.

The definition of fatigue can be expressed as follows: a reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including: strength; speed; reaction time; co-ordination; decision making; or balance.

Fatigue is cumulative; it is built up as a result of inadequate rest over a period of time. It is distinct from tiredness or sleepiness, which is a one-off occurrence. Tiredness can be a symptom of fatigue; they are not the same thing.

Investigating for fatigue

Investigating for fatigue is not as easy as it may first appear. It is much more than a question of looking at work/rest logs; sometimes these may not have the entire story. Investigating for fatigue is a skill that must be acquired and honed. In order to properly establish whether (or not) fatigue was a contributing factor in a casualty one must:

- Have an understanding of how fatigue affects performance.
- Know how to investigate for fatigue.
- Collect the necessary information on the work, rest and sleep periods of the persons involved.

This article should give the reader enough information to be relatively at ease with accomplishing the first two elements mentioned above. The third element, to diligently collect the necessary data, is hard work. Information on hours of work, rest and sleep should be gathered, in the first instance, during the interview. This is accomplished by using a systematic methodology combined with proper preparation and knowledge.

Only if you have done the necessary data collection in respect of work/rest and sleep will you be able to establish if fatigue was a factor or, on the other hand, to rule it out.

How fatigue affects performance

As fatigue increases and eventually becomes overwhelming, a person can fall asleep involuntarily and for varying lengths of time – from a few microseconds to much longer. This is especially true when sustained attention and monotony are involved.

The two extremes of sleep and total alertness can be viewed as a continuum. Alertness steadily decreases the longer one stays awake while fatigue, on the other hand, increases. Only restorative sleep can renew alertness to its peak.

Our state of alertness enables us to decide what is important and what is not; in other words, to prioritise. Alertness is crucial in a person's situational awareness; one of the most important abilities for anyone working on a vessel. Our performance mirrors our level of alertness. With no fatigue we are at our most alert and performance is the greatest. As fatigue becomes more predominant our alertness decreases, as does our performance.

To add insult to injury, all our capacities are degraded by fatigue – physical, mental and psycho-motor. Mood can also be affected by fatigue, and mood is all encompassing, affecting and influencing the other three capacities.

When someone is suffering from fatigue:

- They are less likely to converse
- They are less likely to perform low-demand tasks
- They are more irritable
- They are more distracted by discomfort
- They can display a 'don't care' attitude
- Their reaction time is slower than when they are alert
- They will display a propensity for errors, false responses, and decreased vigilance.

From an operational perspective, this can lead to less than optimal attention, limited situational awareness, and a failure to reliably detect, appreciate, and respond to events in a timely manner. The 'don't care' attitude is a manifestation of how a person's approach to risk changes with fatigue. When fatigued, an individual's 'risk balance' tilts in favour of taking greater risks.

From an investigative perspective, these indicators may be evident from a person's performance, but the persons themselves will probably be unable to detect these factors, much less describe them during the interview. On the other hand, these indicators may be forthcoming during your interview with a person who was working with the presumably fatigued individual. They may mention that the person was uncharacteristically irritable or, contrary to habit, did not converse freely.

Alertness and time of day

This is where **preparation, knowledge of fatigue and active listening** come into play during the interview process. It is also one more good reason to always interview each and every person from the work group involved in the active failure.

Level of alertness depends to a great extent on the time of day that one works rather than the number of consecutive hours worked – although

at the limit, the number of consecutive hours worked certainly take their toll. For example, studies have shown that after 18 hours awake a person's performance decreases by about 30%. However, as long as one benefits from recuperative sleep, one can work extended hours per day and maintain high levels of alertness and performance, as long as those work hours are between 7:00 am and 11:00 pm; in other words if one's work time is in sync with one's biological clock (or circadian rhythm).

It may come as no surprise that alertness drops off at night – a product of our natural circadian rhythm. The time of our lowest alertness is typically in the hours just before dawn – that is between 0300 and 0500. Another dip in alertness occurs in the mid-afternoon usually between 1500 and 1700. If a person is already in a situation of 'sleep debt', alertness can drop off even more significantly at these times.

Since performance mirrors alertness, it can be understood that performance will likewise follow a similar trend with respect to the time of day – dropping off between three and five in the morning and in the afternoon.

Factors affecting alertness

Although alertness is generally a function of how much recuperative sleep has been acquired and the time of day, other specific events or situations can heighten alertness, such as:

- Sense of danger
- Interest or opportunity
- Muscular activity
- Environmental light, temperature, humidity, sound, and aroma
- Ingested nutrients and chemicals
- Controlled, strategic napping

When investigating a casualty, always start by assuming fatigue may have played a role in the events and use the following four questions to either strengthen or discard the fatigue hypothesis:

1. At what time of day (or night) did the casualty take place?
2. Was the person's normal biological clock disrupted?
3. How many hours (or even minutes) had it been since the person woke?
4. Is sleep debt likely given the 72- or even 96-hour sleep history?

The first question speaks to the circadian rhythm and the alertness mentioned earlier while the second question is complementary to the first. The third question flushes out if 'sleep inertia' is possibly involved. Sleep inertia is the groggy state someone can experience after just recently awaking from deep sleep. Sleep inertia can last anywhere from 10 to 60 minutes after waking. The fourth question checks for sleep debt.

As a rule, an individual cannot accurately assess his/her own fatigue. It is up to the investigator, by asking the right questions, to determine if the person was in a fatigued state or not.

You should not ask: 'Were you tired during your watch?' During your data collection you should more correctly ask: 'Please describe to me the periods of rest, work and sleep you experienced, starting from the time of the occurrence and working backwards at least three days.' (Studies have shown that at least 72 but preferably 96 hours of rest, work and sleep data is necessary to assess for fatigue.) As you can see, fatigue in this sense is much more than just being tired at the end of a long day. It is an accumulation of sleep debt over several days. But, that is not to say that after a long hard day a person cannot be so tired that their performance is not affected, even with adequate rest beforehand – it certainly can be. As you can see, investigating for fatigue is not an easy affair.

Recording data

Recording work/rest/sleep data can be complex and confusing. The easiest way to accomplish this task is with the use of a prepared template, such as the one shown here. This example is already

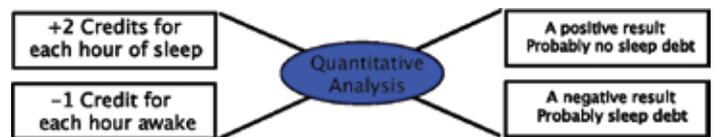
subdivided into the four-hour slices of traditional ship watches to facilitate the recording of the data. You can prepare six-hour watch schedule templates ahead of time too if that system is used on your ships (although I hope it isn't). Or, if the person is a day worker use another more appropriate template. To facilitate the witness's recall, start from the time of the casualty and work backwards in time.

Try and have the witness recall the periods from memory instead of relying on work/rest logs. This may help flush out any less than exact entries made in these logs made out of habit or routine. Use the days of the week as anchors in your questions to help their recall as you go back. For example, if the casualty happened on a Monday, ask them – 'OK, yesterday, on Sunday, what time did you get up for your watch?' 'Before that, what time did you go to bed?' 'Did you do any overtime on Sunday?' 'Did you take any naps on Sunday?' 'Now on Saturday, what time did you get up for your watch?'... and so on.

Occurrence day	0000-0400	0400-0800	0800-1200	1200-1600	1600-2000	2000-2400
work						
rest						
sleep						
Occurrence day minus 1						
work						
rest						
sleep						
Occurrence day minus 2						
work						
rest						
sleep						

Quantitative sleep debt analysis

Once you have the quantitative data on the hours of work, rest and sleep you can perform a 'sleep debt' calculation. Work time and rest time are both considered as 'awake' time while sleep time is only the actual hours spent asleep.



Qualitative analysis

The next step is to bring more depth and meaning to the quantitative sleep equation by performing a qualitative analysis of the sleep period. After you have captured the work/rest/sleep data from the witness, ask the following questions:

- Was their sleep interrupted? Interruptions mean the sleep will probably be less restorative.
- Where did they sleep? If sleep was elsewhere than the regular place of sleep – this could make the sleep less restorative.
- Do they have any sleep pathologies? Obviously, sleep pathologies will also reduce the restorative effects of sleep.

OTHER CONSIDERATIONS

- Work history in the last week.
- Were they on watches or on day work?

- Did they change watch? If so, was the change forward or backward. Changing to a shift that is later than the current one is easier to adjust to than moving to a shift that is earlier (moving back).
- Jet lag (most people adjust more easily to westbound air travel than eastbound).
- Overtime.

Fatigue as a contributing factor

Now for the most important step in the process of investigating for fatigue. In order to establish fatigue as a contributing factor in the casualty, it should be demonstrated both that:

- The person or crew was in a fatigued state using the quantitative and qualitative methods shown.
- The unsafe act or decision is consistent with the **type of behaviour expected** of a fatigued person or crew.

Some behavioural indicators that a person is suffering from fatigue are:

- Impaired judgement (distance, speed, and time).
- Reduced problem solving ability.
- Forgets or ignores normal checks/procedures.
- Preoccupied with single tasks.
- Slower reaction time.
- Reduced situational awareness.

In summary, gathering the necessary fatigue data is not always easy, but it can – and must – be done. Once the data has been collected, use the fatigue check-list below to help establish whether

“ Collecting fatigue data is just as important as any other aspect of a casualty investigation ”

fatigue played a role in the events or not.

One or more ‘Yes’ responses to the primary factors is a strong indication of possible fatigue. Weight will be added to the fatigue hypothesis if there are one or more ‘Yes’ responses to the secondary factors. Finally, if one or more of the behaviour indicators solicits a ‘Yes’ response then, in light of the other responses, you may reasonably conclude that fatigue was a likely contributing factor.

Collecting fatigue data is just as important as any other aspect of a casualty investigation. A good rule of thumb is to always assume fatigue may have played a role in the events and use the techniques described in this article in order to either strengthen or discard the fatigue hypothesis.

Such a methodology not only lends factual credibility to your casualty report in respect of fatigue itself but is also an excellent reflection of proven best practices for the entire investigative process. 🌐

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The Fatigue Checklist			
Factor or indicator		Yes	No
Primary Factors	Does the 72-hour sleep history indicate a sleep debt?		
	Did the casualty happen between 10 and 60 minutes after awakening? (sleep inertia)		
	Was the person’s normal biological clock disrupted? (ie the casualty happened between 11pm and 7am)		
	Did the casualty take place between 3pm/5pm, or alternately between 3am/5am?		
Secondary Factors	Were the person’s recent sleep periods interrupted?		
	Does the person suffer from any sleep pathologies?		
	Did the person recently change watch?		
	If they changed watch, was it going backward – to an earlier shift?		
	Did the person recently cross several time zones in a short period of time (jet lag)?		
Behavioural Indicators	Did the person display difficulty judging distance, speed or time?		
	Did the person display reduced problem solving ability?		
	Did the person forget or ignore normal checks/procedures?		
	Was the person preoccupied with one task or with a task of minor importance?		
	Did the person appear to display reduced reaction time?		
	Did the person appear to display reduced situational awareness?		