

# Human errors and oil pollution from tankers

P. Arsenie & R. Hanzu-Pazara

Constanta Maritime University, Constanta, Romania

**ABSTRACT:** The economical development of the world is based on transportation system. More than half of the products transported all over the world are carried by sea. Sea transportation is made with different kind of ships, as bulk carriers, cargo vessels, container ships, tankers. Ships are managed by people. In group or as individual, anybody can make errors. In maritime area these errors have as results accidents and disasters. Many of these events affect especially the environment. As 80% of necessary petroleum products are transported by sea, the risk of a major environment disaster caused by human errors is high. Anyway, over 99% of petroleum cargo transported by sea is carried without incidents. This paper presents the effects of human errors, mostly cases that involved tankers, which were produced in the navigation and operational processes

## 1 INTRODUCTION

Over the last 40 years or so, the shipping industry has focused on improving ship structure and the reliability of ship systems in order to reduce casualties and increase efficiency and productivity. We've seen improvements in hull design, stability systems, propulsion systems, and navigational equipment. Today's ship systems are technologically advanced and highly reliable.

Yet, the maritime casualty rate is still high. Why? Why is it, with all these improvements, we have not significantly reduced the risk of accidents? It is because ship structure and system reliability are a relatively small part of the safety equation. The maritime system is a *people* system, and human errors figure prominently in casualty situations. About 75-96% of marine casualties are caused, at least in part, by some form of human error. Studies have shown that human error contributes to: 84-88% of tanker accidents, 79% of towing vessel groundings, 89-96% of collisions, 75% of allisions. 75% of fires and explosions.

Therefore, if we want to make greater strides towards reducing marine casualties, we must begin to focus on the types of human errors that cause casualties.

A recent study of 100 marine casualties found that the number of causes per accident ranged from 7 to 58, with a median of 23. Minor things go wrong or little mistakes are made which, in and of themselves, may seem innocuous. However, sometimes when these seemingly minor events

converge, the result is a casualty. In the study, human error was found to contribute to 96 of the 100 accidents. In 93 of the accidents, multiple human errors were made, usually by two or more people, each of whom made about two errors apiece. But here is the most important point: every human error that was made was determined to be a necessary condition for the accident. That means that if just one of those human errors had not occurred, the chain of events would have been broken, and the accident would not have happened. Therefore, if we can find ways to prevent some of these human errors, or at least increase the probability that such errors will be noticed and corrected, we can achieve greater marine safety and fewer casualties.

## 2 THE MARITIME SYSTEM: PEOPLE, TECHNOLOGY AND ENVIRONMENTAL FACTORS

The maritime system is a people system. People interact with technology, the environment, and organizational factors. Sometimes the weak link is with the people themselves; but more often the weak link is the way that technological, environmental, or organizational factors influence the way people perform. Let's look at each of these factors.

First, the people. In the maritime system this could include the ship's crew, pilots, dock workers, Vessel Traffic Service operators, and others. The performance of these people will be dependent on

many traits, both innate and learned. As human beings, we all have certain abilities and limitations.

For example, human beings are great at pattern discrimination and recognition. There isn't a machine in the world that can interpret a radar screen as well as a trained human being can. On the other hand, we are fairly limited in our memory capacity and in our ability to calculate numbers quickly and accurately—machines can do a much better job. In addition to these inborn characteristics, human performance is also influenced by the knowledge and skills we have acquired, as well as by internal regulators such as motivation and alertness.

The design of technology can have a big impact on how people perform. For example, people come in certain sizes and have limited strength. So when a piece of equipment meant to be used outside is designed with data entry keys that are too small and too close together to be operated by a gloved hand, or if a cutoff valve is positioned out of easy reach, these designs will have a detrimental effect on performance. Automation is often designed without much thought to the information that the user needs to access.

Critical information is sometimes either not displayed at all or else displayed in a manner which is not easy to interpret. Such designs can lead to inadequate comprehension of the state of the system and to poor decision making.

The environment affects performance, too. By "environment" we are including not only weather and other aspects of the physical work environment (such as lighting, noise, and temperature), but also the regulatory and economic climates.

The physical work environment directly affects one's ability to perform. For example, the human body performs best in a fairly restricted temperature range. Performance will be degraded at temperatures outside that range, and fail altogether in extreme temperatures.

High sea states and ship vibrations can affect locomotion and manual dexterity, as well as cause stress and fatigue. Tight economic conditions can increase the probability of risk-taking (e.g., making schedule at all costs).

As you can see, while human errors are all too often blamed on "inattention" or "mistakes" on the part of the operator, more often than not they are symptomatic of deeper and more complicated problems in the total maritime system. Human errors are generally caused by technologies and environments which are incompatible in some way with optimal human performance.

These incompatible factors "set up" the human operator to make mistakes. So what is to be done to solve this problem? Traditionally, management has tried either to cajole or threaten its personnel into not making errors, as though proper motivation

could somehow overcome inborn human limitations. In other words, the human has been expected to adapt to the system. This does not work. Instead, what needs to be done is to adapt the system to the human.

The discipline of human factors is devoted to understanding human capabilities and limitations, and to applying this information to design equipment, work environments, procedures, and policies that are compatible with human abilities. In this way we can design technology, environments, and organizations which will work with people to enhance their performance, instead of working against people and degrading their performance.

This kind of human-centered approach (that is, adapting the system to the human) has many benefits, including increased efficiency and effectiveness, decreased errors and accidents, decreased training costs, decreased personnel injuries and lost time, and increased morale.

### 3 HUMAN ERRORS IN TANKERS OPERATION

What do we mean by "human error"? Human error is sometimes described as being one of the following: an incorrect decision, an improperly performed action, or an improper lack of action (inaction). Probably a better way to explain human error and their effects results in environmental damage, as oil pollution is to provide examples from two real marine casualties.

The first example is the grounding of the TORREY CANYON. Again we have clear, calm weather this time it was a daylight transit of the English Channel.

While proceeding through the Scilly Islands, the ship ran aground, spilling 100,000 tons of oil.

At least four different human errors contributed to this accident.

The first was economic pressure, that is, the pressure to keep the schedule (pressure exerted on the master by management).

The TORREY CANYON was loaded with cargo and headed for its deep-water terminal in Wales. The shipping agent had contacted the captain to warn him of decreasing tides at Milford Haven, the entrance to the terminal. The captain knew that if he didn't make the next high tide, he might have to wait as much as five days before the water depth would be sufficient for the ship to enter. This pressure to keep to schedule was exacerbated by a second factor: the captain's vanity about his ship's appearance.

He needed to transfer cargo in order to even out the ship's draft. He could have performed the transfer while underway, but that would have increased the probability that he might spill a little

oil on the decks and come into port with a “sloppy” ship. So instead, he opted to rush to get past the Scillies and into Milford Haven in order to make the transfer, thus increasing the pressure to make good time.

The third human error in this chain was another poor decision by the master. He decided, in order to save time, to go through the Scilly Islands, instead of around them as originally planned. He made this decision even though he did not have a copy of the Channel Pilot for that area, and even though he was not very familiar with the area.

The final human error was an equipment design error (made by the equipment manufacturer). The steering selector switch was in the wrong position: it had been left on autopilot. Unfortunately, the design of the steering selector unit did not give any indication of its setting at the helm.

So when the captain ordered a turn into the western channel through the Scillies, the helmsman dutifully turned the wheel, but nothing happened. By the time they figured out the problem and got the steering selector back on “manual”, it was too late to make the turn, and the TORREY CANYON ran aground.

The second case presented is the grounding of EXXON VALDEZ. The ship’s compliment consisted of four deck officers (captain, chief mate, second mate and third mate), four engineering officers, one radio electronics officer, six able-bodied seamen, three unlicensed engine personnel and two cook/stewards. The vessel personnel in the deck department stood two four hour watches each day with eight hours off in between. All other personnel were day workers. According with international minimum safety manning for this ship would be fifteen crew members (Exxon Valdez had 20 crew members when she grounded on Bligh Reef).

Captain had been off the ship during the day she was loading crude oil in Valdez port. Captain was drinking that day. According blood analyses after that his alcohol concentration was approximately .285 at the time he boarded the ship, to do so without showing some evidence of physical impairment or needing some assistance. Additionally person contacted after by the investigators reported none of the EXXON VALDEZ crew members returning to the vessel were under the influence of alcohol. During the time the pilot was aboard the ship Captain was off the bridge for approximately one hour and thirty five minutes. The pilot smelled alcohol on his breath.

Later on March 23rd, shortly prior to his relief, the helmsman responded to an order from the master to sail the ship 180<sup>0</sup> and put her on automatic pilot. Helmsman was puzzled by this order. He didn’t check it with the master. The master left the bridge

but not before asking the third mate, if he felt comfortable sailing the ship under these conditions. despite his limited experience in sailing the ship at all, he replied that he did.

At 23:47 LT the ship left the Traffic Separation Scheme going into the inbound lane to avoid the ice. At 23:55 LT the helmsman was relieved. The ship was on “load program up” which meant she was increasing her speed while exiting the harbor. Thus, EXXON VALDEZ was traveling at 12 knots and on automatic pilot just prior to hitting Bligh Reef. Putting the ship on automatic pilot in confined waters and not telling the third mate the master had done so was extremely inconsistent with normal practice. At his relief, the helmsman reported to the third mate that the ship was on automatic pilot, something the third mate did not know about. The third mate did not discuss the reason for the automatic pilot with the master.

The third mate holds a second mate’s license, and first sailed as the third mate on an Exxon tanker in January, 1987. He had sailed on five tank vessels owned by the company and had been employed by Exxon for nine years. He had completed approximately 18 voyages in and out of Valdez, sailing in both unlicensed and licensed categories. At the time of the grounding he had approximately 199 days of at sea experience as a third mate.

The night before he slept 6 hours, then after lunch had a cat nap and relieved the chief mate for supper and worked through to the grounding. The third mate had only about a year’s experience as a deck officer. The situation is further complicated because the chief mate had worked the entire time of the loading, was asleep, and was unavailable as an additional resource. In addition to his bridge duties, the cargo is the primary responsibility of a chief mate in the Merchant Marine. This includes loading and discharge of cargo could only be conducted by the second and third mate on duty, the chief mate is normally on hand when loading and discharging are started and concluded. The ship left port at about 21:00 LT.

The third mate decided not to call his relief, the second mate, until after they cleared the ice. The third mate determined there was .9 mile between Busby Island and the ice floe and felt he could pass around the ice. The master left the bridge at 23:52 LT. the third mate relied considerably on the radar, but did not correlate the radar information with the navigation charts through position fixing. The submerged reef was not displayed on the radar.

According with bridge organizational manual used by Exxon, in this situation is stated that two officer be on bridge during this transit. The chief mate was sleeping. Some time before midnight the third mate put the ship in hand steering condition. At the same time he plotted the ship as 1.1 miles from

Busby Island. Before midnight the AB reported a red light flashing every five seconds to the third mate. He acknowledged her and stated that he knew the light to be Bligh Reef. The third mate ordered a right 10 degree rudder but the vessel did not move to this position. There is a six minute delay before the third mate and helmsman respond to the fact that the ship did not begin to turn.

About this time the AB reported the light flashing every 4 seconds on the wrong side of the ship. Now the third mate order a right 20 degree rudder. Moving at 12 knots while the ship was still engaged in maneuvering evolutions to avoid ice violated prudent ship handling practices while increasing risk of damage to the ship if ice floes had been struck. He then orders hard right rudder.

When the ship hit the reef the third mate ordered a hard left rudder to get the ship to stop swinging to the right and prevent the stern from swinging around. The ship had clearly skidded into Bligh Reef. The helmsman was confused about some aspects of the situation. He also reported that the third mate was panicky. The chief engine stop the engine at 00:20 LT.

For about 45 minutes the master tried to get the ship off the reef, probably moving from dead slow ahead to full ahead, and finally slowing down and stop. The chief engineer had advised the master not to move the ship. Vessel Traffic Service had advised to move cautiously. The company declared that the master was not trying to get the ship off the reef because he never put the ship astern.

The chief mate was awakened by the grounding. He went to the cargo control room to assess the damage. He determined that the stress on the ship exceeded acceptable limits and took this information to the master. The chief mate performed further analyses and concluded that if the vessel were not supported by the reef it would capsize. He relayed this information to the master who, for an additional half hour tried to get the ship off the reef.

In this case, like in the first presented, a amount of human errors concurred to the disaster. The errors are from the area of navigation and ship characteristics acknowledgement, bridge management regulations, communication's on bridge and on board the ship, crew competencies.

Below we'll try to show some of these errors, according with facts and regulations applied for this situation.

A number of dynamics occurred on the bridge. The first is that the two key players aren't there. The company manual stated that the master or chief mate must be on the bridge while exiting port and the law requires a first class pilot's license or endorsement for the waters. The situation warrants the added

responsibility of the master to be on the bridge, not the chief mate during loading and discharging operations. Sufficient redundancy might have been in the system if one of these people had acted as a second pair of eyes for the third mate. Second, no one checked the reasoning behind orders. From this account we don't know if the helmsman may have had reason to question the situation (gyro, load program up conditions). The AB may have questioned in his mind what they were doing. If he did he didn't find a way to direct attention to that question without putting himself in danger of incurring the third mate's wrath.

Overall, one might suspect this kind of unprofessional seamanship on the part of the captain, the third mate and the helmsman had occurred before. Such behaviors usually don't emerge full blown, they grow over time. There is sufficient evidence from the company that the captain had problems managing people and there is some similar evidence that the third mate found it difficult to keep supervisors informed about what he was doing. There is nothing that indicates training or a culture that values open communication among bridge personnel. An appropriate culture of safety and vigilance seems not only to have been in place. The watch cycles (4 on, 8 off, 4 on, daily) seems an inherent part of the organization.

Looking at the performance evaluations of the helmsman, it is clear he was not very competent. A master should not leave the team of an incompetent helmsman and a third mate with little experience to run a tanker through an ice field. In this case the pulls and pushes on the master lead to his failing to think about this issue.

The EXXON VALDEZ didn't operate in isolation from the relationships various participants had with one another. The pilot smelled liquor on the master's breath and didn't report it to anyone. The relationship between pilots and master's is sensitive, and the pilot's job future is an important respects depends on what the master thinks of him. Through this relationship seems cast in stone it may well be time to examine it thoroughly. Similarly, the relationship of the VTS at Valdez and the EXXON VALDEZ was one of very little attention even to the giving of advice. This kind of quasi advice only versus direction issue must be looked at in both cases.

Crew aren't in place for the operation of a culture which stresses the existence of risk and risk avoidance. They aren't in place for good communication among the parties, they may not be in place for engaging in good training which can help the bridge team interact appropriately. In addition, if anyone in the bridge group was not

competent, the rewards are not in place for getting rid of that person or retraining him.

#### 4 CONCLUSIONS

We have seen that human error (and usually multiple errors made by multiple people) contributes to the vast majority (75-96%) of marine casualties, making the prevention of human error of paramount importance if we wish to reduce the number and severity of maritime accidents. Many types of human errors were described, the majority of which were shown not to be the “fault” of the human operator. Rather, most of these errors tend to occur as a result of technologies, work environments, and organizational factors which do not sufficiently consider the abilities and limitations of the people who must interact with them, thus “setting up” the human operator for failure. Human errors can be reduced significantly. Other industries have shown that human error can be controlled through human-centered design. By keeping the human operator uppermost in our minds, we can design technologies, work environments, and organizations which support the human operator and foster improved performance and fewer accidents.

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