Exxon Valdez: Human Error, Plain and Simple

by Arthur D. Barondes, Alexandria, Virginia

Much has been made of the *Exxon Valdez* going aground on Bligh Reef in Prince William Sound in 1989 — and rightfully so. The effects of the disaster continue to this day. Why the *Exxon Valdez* went aground is straightforward, although not widely well understood. As can be expected, various interests seized upon the catastrophe to support their causes or improve their lots. Whereas it is now clear that the ship went aground purely as a consequence of human errors — there were no mechanical or electrical failures — the event has been used to justify changes that, while desirable, would not have prevented the *Exxon Valdez* from going aground, or the subsequent oil spill. Those changes include, inter alia, a variety of improved navigational aids, expanded Coast Guard monitoring capabilities, increased requirements for harbor pilots and required crew rest. In looking back, one might be led to believe that the ship went aground in a sea of red herrings. This article reviews what really happened on that night and incontrovertible evidence that supports human errors — onboard the *Exxon Valdez* and thousands of miles away at the Exxon Shipping Company — in a failed safety culture as solely responsible for the disaster.

Introduction

Most of you have at least heard of the *Exxon Valdez* disaster. You probably remember it as a tanker that went aground in Alaska and spilled 11 million gallons of crude oil into natural habitats. Some of you might even remember that the ship's captain was accused of being intoxicated and driving the ship aground. Those who followed the story of the *Exxon Valdez* might also recall some of the wide array of offered explanations, as well as the recommended corrective "fixes." There is some truth to such recollections. The *Exxon Valdez* certainly did go aground and spill a huge quantity of crude oil. But the story of why it went aground is now quite clear. Equally clear is the inability of those recommended fixes to have had any effect on preventing the accident. This is that story.

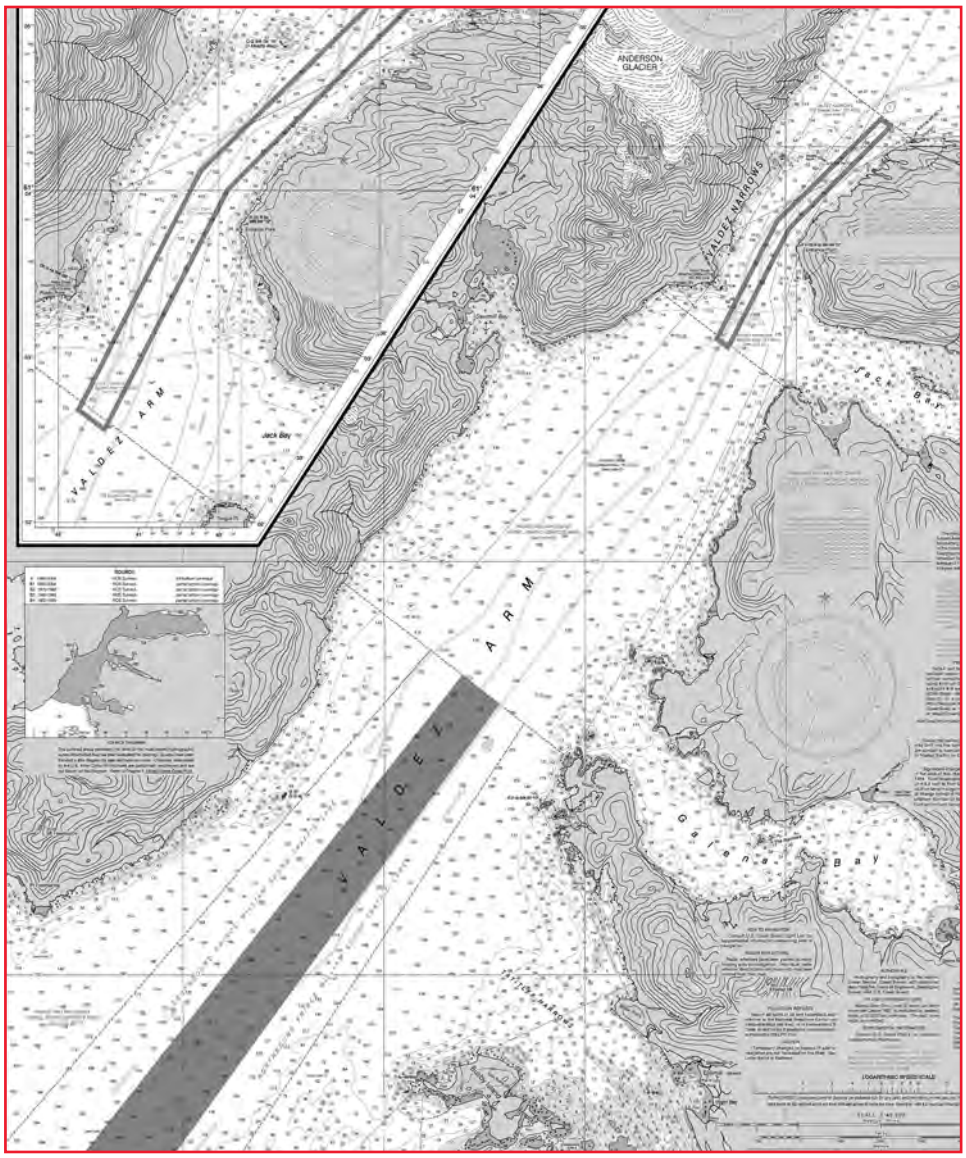
We begin with a brief description of what is supposed to happen, i.e., normal tanker operations in Valdez Bay and Prince William Sound. We follow that with a description of what *actually* happened on that fateful night in March, 1989. That description pinpoints the immediate causes of the ship going aground — all of them human failures. Then, we examine the array of recommended fixes and identify why each one would not have prevented the accident. Finally, we show that the accident was solely the consequence of human failures in an inadequate safety culture. We assert that the accident would not have occurred if the *Exxon Valdez* crew and Exxon Shipping Co. management had complied with established and published human performance procedures.

Figure 1 — Exxon Valdez.

Routine Valdez Tanker Operations

Valdez is a small town (population ~4,000) some 120 miles east of Anchorage, Alaska. As shown in the nautical charts in Figure 2, Valdez is located on the northeast side of Valdez Bay. It is the only cultural center on the Bay. On the south side of the Bay, the Alyeska Marine Terminal is used to store crude oil piped from the Alaska North Shore and transship it to seagoing tankers. On average, two loaded tankers sail from Valdez every day. In the 12 years before the *Exxon Valdez* accident, there had been nearly 9,000 tanker sailings without a single oil spill from going aground.

Tankers sailing from the Alyeska Terminal follow a controlled route. They proceed into Valdez Bay, navigate through the Valdez Narrows into the Valdez Arm of Prince William Sound (Figure 2), and then into sea lanes to their off-loading destinations: Panama, Los Angeles or San Francisco. The Coast Guard Vessel Tracking Center (VTC)/Marine Safety Office (MSO) controls and monitors traffic in the Bay, and controls the inbound and outbound traffic lanes in the Traffic Separation Scheme (TSS) in the Valdez Arm of Prince William Sound to



NOAA Graphic

Figure 2 — Valdez Bay and Prince William Sound

within about six miles of Valdez Narrows (the entrance to Valdez Bay and Port Valdez). The traffic lanes are almost a mile wide in most of the Sound, but gradually decrease to 3,000 feet approaching the Narrows. In 1989, a harbor pilot was required to steer ships in the Bay and through the Narrows. The ship's master is required to be on the bridge with the pilot, as well as when navigating in coastal waters, e.g., the Valdez Arm of Prince William Sound. By and large, such tanker operations are uneventful, with the primary hazard to navigation being small to moderate-size icebergs drifting south from Columbia Glacier into the outgoing lane, but also into the incoming lane of the TSS.

What Happened on the Night of March 23, 1989

The sequence of events leading to *Exxon Valdez* going aground has been documented by the National Transportation Safety Board (NTSB) Marine Accident Report [Ref. 1]. The ship arrived at Valdez at 11:35 p.m. on March 22, docked at the Alyeska oil loading terminal and prepared to load 1.25 million barrels of crude oil [Ref. 1]. With the ship loaded on March 23, the third mate completed the testing of all required navigation equipment and found it operating properly. The ship departed the terminal at 9:12 p.m. that evening — an hour earlier than originally planned. The master was on the bridge with the chief mate, the helmsman and the required State harbor pilot. As the ship departed under the control of the harbor pilot, the third mate relieved the chief mate, and the master — contrary to regulations — left the bridge. The master did not re-appear until requested by the pilot after clearing the Narrows, putting the ship on its outbound course of 219° (all headings are True) and preparing to disembark. At 11:25 p.m., the master, in control of the ship, reported his position to the Coast Guard VTC. He advised that he was proceeding in the outbound lane of the Traffic Separation Scheme (TSS), with the ship's speed programmed to accelerate from the Narrows' speed limit of 6 knots (7 mph) to "sea speed" of 16.25 knots (18.8 mph) — a procedure that would take about 43 minutes, i.e., until about 1:08 a.m. on March 24.

As the *Exxon Valdez* continued into the Valdez Arm of Prince William Sound, this 45-minute critical chain of events evolved:

11:25 p.m.: The Coast Guard watchstander at the Valdez Marine Safety Office (MSO) requested a report on ice conditions in the channel. The master responded in a slurred voice, "Okay. I was just about to tell you that, ah, judging by our radar, I we'll probably divert from, ah, the TSS and end up in the, ah, inbound lane if there's no conflicting traffic." The watchstander confirmed that the inbound channel would be free of traffic, to which, the master responded, "That will be fine. Yeah. We may end up over in the, ah, inbound lane, outbound transit. Ah, we'll notify you when we leave the, ah,

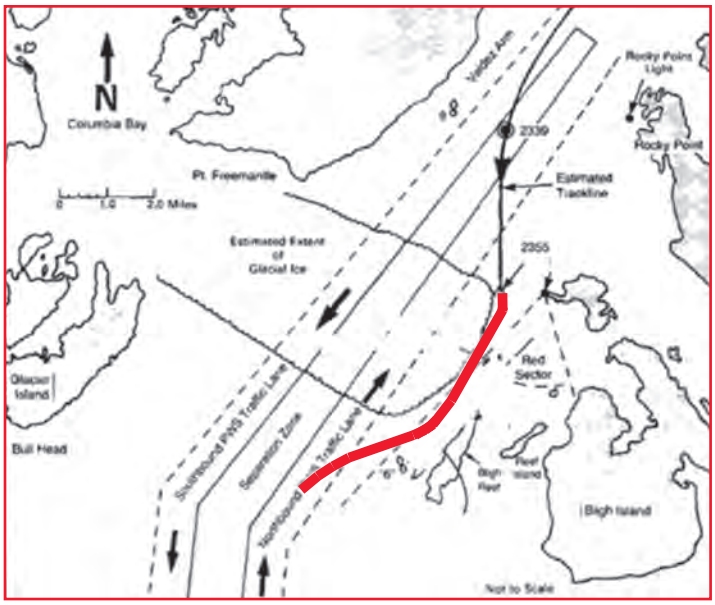


Figure 3 — Master's Planned Course

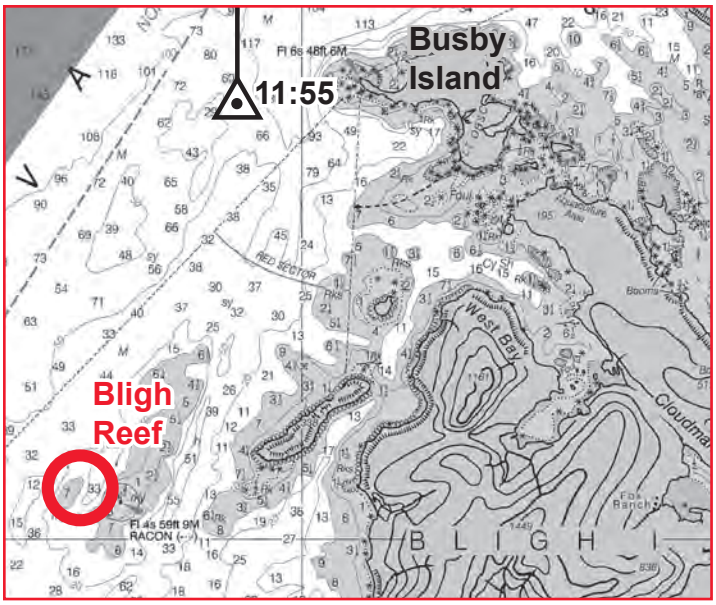


Figure 4 — Exxon Valdez *abeam.*

TSS and, and, ah cross over the separation zone." (Note: Coast Guard approved deviations from the established TSS lanes were common practice to avoid ice.)

11:31 p.m.: The master directs the helmsman to come port (left) to 200° and advises the Coast Guard watchstander, "I'm going to alter my course to 200° and reduce speed to about 12 knots to, ah, wind my way through the ice…." However, the master does not change the activated ship speed program to increase to sea speed (16.25 knots, 18.8 mph).

11:36 p.m.: The master directs the third mate, who has just returned from assisting the pilot off the ship, to take a fix of the ship's position. He tells the third mate that he will move the ship more quickly across the TSS by bringing it farther port (left) to 180° — due south — to skirt the ice (Figure 3). The third mate takes his fix with a visual bearing on Busby Light and radar range.

11:39 p.m.: The fix shows the ship to be in the separation channel.

11:43 p.m.: The ship is steady on a course of 180°. As directed by the master, the helmsman engages the autopilot. Changeover to the 0000-0400 watch is about to start with the master, the second mate and a new helmsman on the bridge. The master authorizes the oncoming forward lookout (who has a cold) to take her post on the starboard (right) wing of the bridge.

11:50 p.m.: The helm watch changes with the ship steady on 180° and on autopilot. (Note: Policy prohibits the use of the autopilot when navigating in the traffic lanes.) The master advises the third mate that he will be leaving the bridge "to do paperwork." He instructs the third mate to turn the ship back to the traffic lanes when abeam Busby Light and to advise him that he has started the turn. He asks the third mate if he feels "comfortable" with what he is to do. (Note: As shown in Figure 3, the master has the ship crossing the TSS inbound lane rather than entering it as approved by the Coast Guard.) The third mate, who is not certified to control the ship in coastal operations, decides to remain on watch until the vessel has cleared the ice and not call his relief, the second mate, who is scheduled to come on watch at 11:50.

11:52 p.m.: The master leaves the bridge. (Note: The Exxon Shipping Company "Bridge Organization Manual," requires that either the master or the chief mate be on the bridge in charge of the watch when arriving or leaving port or in congested waters.) The third mate, expecting to alter course, takes the ship off autopilot. This is observed by the helmsman.

11:55 p.m.: The ship is abeam Busby Light — three minutes after the unauthorized departure of the master. As the third mate is plotting the fix (Figure 4), the lookout advises him that the red light of Bligh Reef is to starboard (right). (Note: A red mark to starboard when leaving port is cause for concern, but with the ship deliberately heading due south across the TSS, the red light of Bligh Reef should have been to starboard.)

11:56 p.m.: One minute late, the third mate orders, "Ten degrees starboard (right) rudder." In a crucial oversight, he fails to check the rudder indicator on the bridge. After ordering the right rudder, he telephones the master as directed and informs him that he has started to turn the vessel back toward the traffic lanes. The master asks if the second mate is on the bridge. He tells him that the second mate has not been called. The ship is still building to "sea speed."

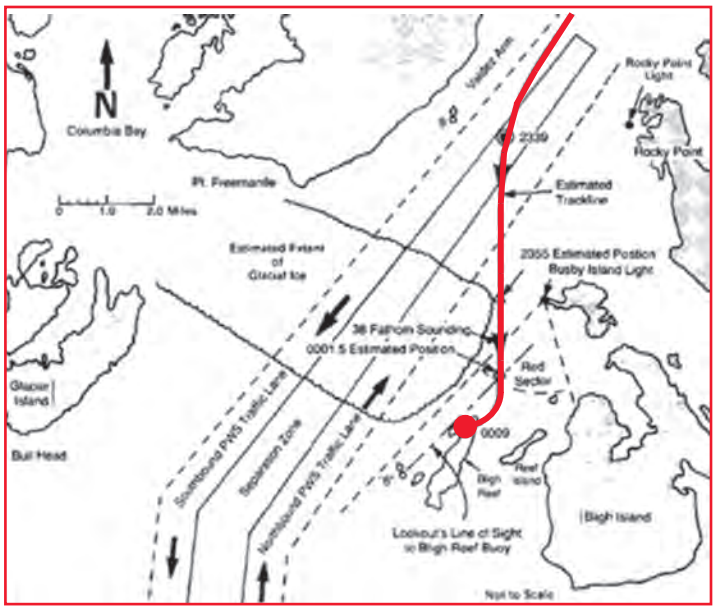


Figure 5 — Track of the Exxon Valdez.

11:57 p.m.: Off the phone, the third mate goes to the port radar and takes radar ranges from Bligh Reef buoy and Reef Island, which he has in sight, to determine the ship's change in course. There is none. (Note: Large ships, such as the 214,861-deadweight-ton *Exxon Valdez*, have large steering time constants, i.e., they respond slowly to rudder inputs.)

11:59 p.m.: Now four minutes late, the third mate orders, "20 degrees right rudder." He checks the ship's rudder indicator to confirm the change. He notes that the ship is not yet in the "red sector" of Busby Light (Figure 4).

00:01½ a.m.: The ship starts to turn.

00:02 a.m.: The third mate calls for "hard right rudder." The helmsman complies.

00:04 a.m.: The third mate telephones the master and says, "I think we are in serious trouble."

00.05 a.m.: As the telephone conversation is completed, the third mate feels the vessel contact the bottom. The ship speed is about 14 knots (~16 mph) with ~3E9 ft lb of kinetic energy being dissipated.

00:09 a.m.: The ship is aground on Bligh Reef (Figure 5).

00:27 a.m.: Eighteen minutes after going aground, the master advises the Coast Guard Vessel Traffic Control (VTC): "Yeah. Ah, it's *Valdez* back. Ah, we've — ah, should be on your radar there — we've fetched up, ah, hard aground north of, ah, Goose Island off Bligh Reef. And, ah, evidently, ah, leaking some oil, and, ah, we're gonna be here for a while. And, ah, if you want, ah, so you're notified."

The *Exxon Valdez* story continues to play out, surfacing important issues, such as containing the oil spill, getting the ship off the reef and minimizing the environmental impact. But those issues are irrelevant in determining why the ship went aground on Bligh Reef and what actions would prevent other ships from facing a similar fate. Those actions — recommended and adopted — are the subject of the next section. But, before addressing them, it is important to note from the foregoing description of events that:

- The *Exxon Valdez* had no mechanical or electrical failures
- The ship had a complete suite of navigational equipment (Table 1)
- There were no failures with Coast Guard navigational aids
- The ship responded properly to the orders it received
- The master and, subsequently, the third mate, knew exactly where the ship was at all times
- Failure to execute the rudder order at 11:55 sealed the fate of the *Exxon Valdez*.

Table 1 — Navigation Suite.

Ship Control Center Sperry SRP-2000
RADAR Raytheon RAYCAS V S-band (out of commission) Raytheon X-band (2)
LORAN C
VLF Omega
NavSat (Transit)
GPS

Figure 6 — Exxon Valdez *aground.*

Explanations and Fixes

There has been no shortage of claims made to explain the *Exxon Valdez* going aground (Figure 6). Those claims — offered by various interests and sources ostensibly to prevent a recurrence of ships going aground in the Valdez Arm of Prince William Sound — have led to a variety of proposed, and oft-adopted, fixes. For the most part, these so-called fixes neglect to recognize that the *Exxon Valdez* went aground because of a series of strictly human failures. Worse, they were predominantly a failed safety culture that tolerated deliberate failures to adhere to established policies and procedures. It was not because of mechanical or electrical failures or shortcomings in Coast Guard navigational aids and supervision.

Some claims are based on assertions that are *demonstrably false*. As an example, "The captain was confirmed to be asleep when the ship crashed in Prince William Sound's reef" [Ref. 2]. Note that the third mate was on the phone with the master twice (11:56 p.m. and 00:04 a.m.) in the 10-minute period before the initial impact at 00:05 a.m. Many other offerings simply miss the point. In that context they are, in effect, red herrings in Prince William Sound. Specific examples include:

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The RAYCAS V Radar — Much has been made of the failure of the Exxon Shipping Co. to maintain the ship's advanced Raytheon Collision Avoidance System (RAYCAS) radar. One popular, but implausible, claim asserted that the radar "if functional, would have indicated to the third mate an impending collision with the Bligh Reef by detecting the 'radar reflector' placed on the next rock inland from Bligh Reef for the purpose of keeping boats on course via radar" [Ref. 3]. In another, "the radar system would have detected the 'radar reflector,' placed on the next rock inland from Bligh Reef for the purpose of keeping boats on course via radar" [Ref. 4]. In still another, "At the helm, the third mate would never have collided with Bligh Reef had he looked at his RAYCAS radar. But the radar was not turned on. In fact, the tanker's radar was left broken and disabled for more than a year before the disaster, and Exxon management knew it. It was just too expensive to fix and operate" [Ref. 5].

Whereas the RAYCAS V was a technologically advanced maritime radar system, it was not part of the suite of "minimum essential equipment" necessary to comply with the safety requirement for two operating radars. The RAYCAS V capability to "paint" the Bligh Reef corner reflector was not unique. As described earlier, at 11:57, the third mate had the light of the Bligh Reef mark in sight and was using a less-sophisticated RAYCAS radar (the port-side radar) to take range and bearing fixes. Whereas it could be argued that the RAYCAS V would have been more capable, that was not an issue: The position of the *Exxon Valdez* was never in doubt.

The Coast Guard — In a report addressing the Valdez accident, the Coast Guard enumerated the the changes required of it by the Oil Pollution Act (OPA) passed by Congress in 1990: "To strengthen (the Coast Guard's) regulations on oil tankers and their owners and operators. Today, tank hulls are specially designed to provide maximum protection against oil spills. Communications between vessel captains and vessel traffic centers have improved for safer sailing. In addition, the Coast Guard implemented stronger regulations on vessel traffic:

- The addition of three people at the Coast Guard's Vessel Traffic Service (VTS) to provide additional watchstanders round the clock
- The close monitoring of fully laden tankers by satellite as they pass through Valdez Narrows and exit Prince William Sound. In 1989, only Valdez Narrows and Valdez Arms were watched. [Note: The Coast Guard had two remote radar sites: one adjacent to its Valdez office and one at Potato Point (southwest end of the Narrows).]
- The continuous plotting of progress of all tankers in the Valdez channel
- The improvement of foul weather surveillance [sic] capability with the installation of an all-weather radar system….

- The erection of a major lighted aid to navigation at Bligh Reef" [Ref. 6].

Regarding the marker at Bligh Reef, one source [Ref. 7] went so far as to claim erroneously, "The *Exxon Valdez* ended up on Bligh Reef because they did not follow the correct route and did not see the warning markers."

While improved markers are desirable, they and the other improvements cited here — if present when the *Exxon Valdez* went aground — would not have prevented the accident. True, the position and course of the *Exxon Valdez* were not known to the Coast Guard VTC as the accident was playing out. But both the position and course were well known to the master until he left the bridge three minutes before the critical course alteration was to be made. As detailed in the NTSB Marine Accident Report [Ref. 8], the third mate, in control after the master departed, knew the position of the ship throughout its progress to Bligh Reef. In fact, the third mate was consumed with position fixing to the neglect of steering the ship and controlling its speed.

The MIT Analysis — A group at MIT examined the *Exxon Valdez* accident as part of "A New Approach to System Safety Engineering" [Ref. 9], wherein the thrust was to design safety into systems so as to preclude accidents. Whereas their approach is admirable, the use of the *Exxon Valdez* as a case in point — including questioning the culpability of the master — is not. Using the catch question, "Was he [the master] to 'blame'?" the "New Approach" identifies eight dubious causative factors that "spread the blame" and reduce the key role of human failures:

- "State-of-the-art iceberg monitoring equipment promised by oil industry, but never installed." This could be true, but it is not a causative factor unless the argument is made that the *Exxon Valdez* altered course on the basis of non-existent ice. But, there is no evidence to support that. Hazardous ice buildups from calving glaciers are common occurrences in Prince William Sound and, as on this occasion, appeared on ship's radar. A common practice, endorsed by the Coast Guard, was to steer around such build-ups, as was being done by the *Exxon Valdez* and other ships that day.
- "Radar station in city of Valdez, which was responsible for monitoring the location of tanker traffic in Prince William Sound, had replaced its radar with much less powerful equipment. Location of tankers near Bligh Reef could not be monitored with this equipment." The Coast Guard Valdez Marine Office of Safety (MOS) was primarily concerned with ships in the Valdez Arm near the Narrows, the Valdez Narrows and Valdez Bay. It provided tracking information out into the Valdez Arm and Prince William Sound as a service — not a requirement. That night, the Coast Guard watchstander had the Valdez Arm radar (at Potato Point) set on short range and was not tracking the *Exxon Valdez*. When the *Exxon Valdez* was reported aground, the watchstander set the radar to long range and immediately detected the ship (albeit now broadside to the radar). It could be argued that had the Coast Guard been tracking the *Exxon Valdez*, it could have warned that it was on a dangerous course, but the master knowingly set the ship on that course and the Coast Guard knew he had turned south. The ship's course became unrecoverable when the third mate failed to make the ordered turn. Again, it is important to note that the position of the *Exxon Valdez* was not in doubt.
- "Congressional approval of Alaska oil pipeline and tanker transport network included an agreement by oil corporations to build and use double-hulled tankers. *Exxon Valdez* did not have a double hull." Clearly, except to the extent that it affects the draft, the hull construction of the ship is irrelevant to going aground. Even so, the maximum vertical damage penetration measured…was 10.9 feet in two locations [with] transverse frames…deformed upward from 8 to 15 feet…. thus, minor leakage probably could still have occurred…. [But,] any outflow would have been expected to be considerably slower if the vessel had had a double bottom…" [Ref. 10]. The double-hull issue is another red herring when examining why the *Exxon Valdez* went aground.
- "Crew fatigue was typical on tankers. Crews routinely worked 12- to 14-hour shifts, plus extensive overtime." Although difficult to measure, various degrees of crew fatigue can be inferred from their on-duty time and sleep history. Long shifts for some crew members were characteristic of loading and unloading the ship, but not during the longer periods at sea. Normal watches underway were four hours on, eight hours off. There is no evidence that the master was suffering from overwork or sleep deprivation. Conversely, the *unqualified* third mate, who was in control of the ship by virtue of a human failure by the master, was judged by the

accident investigation board to have been impaired by "fatigue and excessive workload," even though he made the decision not to be relieved by the rested and qualified second mate. The malassignment of personnel on the bridge was magnified by the change in departure time (9:00 p.m. rather than 10:00 p.m.) that put the ship in the critical Bligh Reef region during watch changeover (11:50 p.m.) rather than an hour into the second mate's watch (00:00 a.m. to 04:00 a.m.).

- "Coast Guard at Valdez assigned to conduct safety inspection of tankers. It did not perform these inspections. Its staff had been cut by one-third." There is no evidence that the *Exxon Valdez*, before or after the accident, had any safety deficiencies. Another red herring: As attested by the harbor pilot, the third mate's inspection and the accident investigation, all required systems were functioning properly.
- "Tanker crews relied on the Coast Guard to plot their position continually. Coast Guard operating manual required this. Practice of tracking ships all the way out to Bligh Reef had been discontinued. Tanker crews were never informed of the change." This is simply a misconception. The crew of the *Exxon Valdez* did not rely on the Coast Guard to plot its position. The mate on watch had the responsibility of plotting the ship's position. Further, the position of the *Exxon Valdez* was never in doubt. (Note: The *Exxon Valdez* also had Global Positioning Satellite (GPS) capability, but there is no reference to it being used.)
- "Spill response teams and equipment were not readily available. Seriously impaired attempts to contain and recover spilled oil." Whereas this is true, it actually has no bearing on the *Exxon Valdez* going aground.
- "[The master] was tried for being drunk the night the *Exxon Valdez* went aground. He was found 'not guilty.'" This is true, but the implication that he was not impaired by alcohol is not. Through a series of glitches, the blood alcohol sample was not taken until some 10 hours after the accident. Although the alcohol content was unacceptably high, the master's lawyer successfully argued that those results could be attributable to alcohol consumed by the master after the traumatic accident — notwithstanding that alcohol was not permitted aboard the ship. An in-depth, but not conclusive, frequency analysis of the master's speech [Ref. 11], recorded by the Coast Guard *before* the accident (see previous examples at 11:25 p.m. and 11:31 p.m.), found it consistent with alcohol impairment. The accident investigation concluded the master was alcohol-impaired at the time of the accident.

Human Failure, Plain and Simple

A careful review of the facts shows that the *Exxon Valdez* did not go aground because of any mechanical or electrical failures, the absence of Coast Guard oversight or inadequate navigational aids. Rather, it went aground solely because of a series of human failures — primarily failures to comply with established regulations, policies and procedures — starting well before the actual event. The number of human failures is sufficiently large as to require questioning the safety culture in the Exxon Shipping Co. and, in particular, the senior crew of the *Exxon Valdez*. Significant human failures include:

Human Failure 1 — Well before the accident, the Exxon Shipping Co. was aware that its master of the *Exxon Valdez* was an alcoholic with a record of "driving under the influence." In accordance with company policy, crew members with an alcoholic dependency are required to complete a rehabilitation program, followed by abstinence. The master did neither. This policy also "prohibits the use, possession, distribution, or sale of drugs and alcohol on company premises…[and forbids] being unfit for duty because of the use of drugs or alcohol…" [Ref. 12]. Further, crew members had reported to company management that the master was drinking and observed him openly drinking in Valdez the day the ship sailed. In effect, the company "looked the other way" and continued him as the master. Had the company human resources and medical departments complied with company policy, there would have been another master onboard the *Exxon Valdez*.

Human Failure 2 — Before the *Exxon Valdez* sailed for Valdez, an Exxon seaman reported to Exxon Shipping Co. management personnel that the master was using alcohol. No action was taken.

Human Failure 3 — The master is observed by other crew members to be drinking in Valdez before the *Exxon Valdez* sails. No action was taken.

Human Failure 4 — The master did not comply with the requirement to be on the bridge as the pilot takes the ship from the Alyeska Terminal into Valdez Bay and through the Valdez Narrows. He saw the pilot off only after the pilot requested his presence.

Human Failure 5 — Contrary to standard operating procedures, the master ordered the ship's programmed speed control to achieve Sea Speed (16

knots) in the coastal waters of Prince William Sound. A consequence of this human failure is a higher speed than allowed, greater turning radius and more damage when going aground.

Human Failure 6 — In response to Coast Guard approval to use the inbound traffic lane, the master told the Coast Guard that he was altering, heading to 200° to enter the inbound lane of the TSS. He subsequently steered 180° to expedite transit through the separation zone, through the inbound lane and into hazardous waters before his planned turn back onto the outbound heading. He failed to advise the Coast Guard of this change in heading.

Human Failure 7 — The master put an unqualified third mate in control of the ship.

Human Failure 8 — The master, required to be on the bridge, left the bridge "to do some paperwork" — a scant three minutes before the critical course alteration was to be made.

"Human failures in commission and omission of key actions by the master sealed the fate of the *Exxon Valdez*. Clearly, as required by company policy, he should have been replaced as master until successfully completing an approved rehabilitation program. Was anyone else to blame? Here again, the evidence supports a 'yes.'"

Human Failure 9 — The third mate decided he should stay in control of the ship rather than have the scheduled and qualified second mate take control. (Note: If the watch change to the second mate had started as scheduled at 11:50 p.m., the changeover briefing, with the master present, would have covered the rudder change to be made abeam Busby Light at an estimated time of 11:56 p.m.)

Human Failure 10 — The third mate and the helmsman, between them, failed to initiate the critical course alteration that would miss Bligh Reef. The third mate, in control, failed to monitor the ship's rudder position.

Conclusion

To the MIT question, "Was he to blame?" we assert the evidence — as presented here — supports an unarguable "yes." Human failures in commission and omission of key actions by the master sealed the fate of the *Exxon Valdez*. Clearly, as required by company policy, he should have been replaced as master until successfully completing an approved rehabilitation program. Was anyone else to blame? Here again, the evidence supports a "yes." The omission of key actions by the Exxon Shipping Co. to execute its written policy on alcohol and drug use allowed the master to be in a position to make the decisions that led to the *Exxon Valdez* going aground.

As for the third mate, we assert that he bears some responsibility for the accident by not recognizing his limitations. Whereas he claimed to be "comfortable" following the master's orders, we picture him as a relatively inexperienced mate eager to gain experience in controlling the *Exxon Valdez* in coastal waters — a job both he and the master knew was above his "pay grade." We see him making three serious "rookie" mistakes:

First, he neglected to confirm his rudder order by observing the rudder indicator. Whereas it cannot be substantiated with evidence, we see the confusion between the third mate and the helmsman on the use of "hand steering" or autopilot as the key contributor. It appears that the helmsman used the autopilot to put in the 11:56 order for "10 degrees starboard rudder" when the ship was in hand steering mode.

Second, his navigation prowess is at issue. We would argue that considering the criticality of the turn abeam Busby Light, it was another "rookie" mistake to wait until the ship was "abeam Busby Light" to take his fix. A more experienced navigator would dead reckon (DR) ahead from the last fix to the turning point and use that estimated time of arrival (ETA) to have the helmsman put in 10 degrees starboard rudder, or alternatively order the turn on his "mark" when visually abeam Busby Light. This would have saved one or two critical minutes equating to a quarter or a half-mile — perhaps enough for subsequent unintended events to play out and still miss Bligh Reef.

Third, again related to his navigation prowess, at 11:59 p.m. he failed to recognize the potential catastrophic consequences of the ship not turning. He called for a modest "20 degrees starboard rudder" to make up for the missing 10 degrees starboard rudder. Had he called for "hard starboard rudder" as he did three minutes later at 00:02 a.m., the ship would clear Bligh Reef. Also, he failed to slow the ship as it continued its programmed increase in speed and associated growing turning radius.

Whatever the reasons for the accident, it is interesting to note that subsequent simulations showed that had the master's rudder order (10 degrees starboard rudder

when abeam Busby Light) been executed, the *Exxon Valdez* would have missed Bligh Reef and continued on an uneventful trip. The master would have continued his career and no one would have been the wiser — until his next cataclysmic human failure.

The recommended and actually implemented "fixes" have the appearance of enhancing the safety of maritime operations in Prince William Sound. But they would not have prevented what happened to the *Exxon Valdez*. Most of them relate to determining the accurate positions of ships — something not at issue with the *Exxon Valdez*. Hence, the fixes are largely red herrings. Only the use of a pilot all the way to Bligh Reef (essentially removing control from the master) offers any hope of having kept the *Exxon Valdez* off the reef — assuming the pilot does not make cataclysmic human errors.

"The recommended and actually implemented 'fixes' have the appearance of enhancing the safety of maritime operations in Prince William Sound. But they would not have prevented what happened to the *Exxon Valdez*."

As a post script, with all the attention on the *Exxon Valdez* and the host of subsequent fixes and "improvements," "a [136-ft] tugboat [drawing only 19 feet and scouting icebergs] …ripped open on Prince William Sound's Bligh Reef in 2009…. [The captain] was unaware of the boat's position when he put it on a crash course with the infamous and well-known navigational hazard…. [The captain] changed the tugboat *Pathfinder's* course, increased its speed and was playing a computer game just before it ran aground…" [Ref. 13]. We would say this was unarguably another human failure, plain and simple. Again, there were no mechanical or electrical failures. Also, there was no doubting the answer to the question: "Was the captain to blame?" Although sober, he and his mate were summarily fired.

So much for the many analyses of the infamous *Exxon Valdez* going aground and the so-called fixes subsequently introduced a decade ago.

About the Author

Arthur Barondes, a principal at AIC, has developed, conducted and peer-reviewed probabilistic QRAs for 22 years. He worked on the "DoD/DOE Transportation Safety Study," developed the Weapon System Safety Assessment (WSSA) methodology for nuclear weapon systems, and led the peer-review teams for subsequent WSSAs and for the DDESB-requested SAFER program review. Earlier experience includes 11 years supporting the Defense Nuclear Agency "Theater Nuclear Forces Improvement Program" in Europe and 27 years in the Air Force, including command of a Minuteman III ICBM wing, and experimental flight test of Air Force and Navy air-to-air missile systems. He is a rated Master Navigator with 4,500 flying hours. He has a BS from the U.S. Military Academy, an MS(Aero) from the University of Michigan, an MBA from George Washington University and did his doctoral work at American University. He is a distinguished graduate of the National War College.

References

1. National Transportation Safety Board (NTSB), Marine Accident Report: *Grounding of the U.S. Tankship* Exxon Valdez *on Bligh Reef, Prince William Sound near Valdez, Alaska March 24, 1989*, PB90-916405, NTSB/MAR-90/04, Washington, DC:, Office of Surface Transportation Safety, 1990.
2. http://www.solarnavigator.net/boats/exxon_valdez.htm
3. Ibid.
4. http://en.wikipedia.org/wiki/Greg_Palast#Exxon_Valdez
5. http://www.gregpalast.com/court-rewards-exxon-for-valdez-oil-spill/
6. Hq USCG, *The Coast Guard's Role in the* EXXON VALDEZ *Incident*, Historian Office, Washington, DC http://www.uscg.mil/history/articles/EV.pdf
7. http://answers.yahoo.com/question/index?qid=20080109150820AAyLbG3
8. NTSB, op. cit.
9. Levinson, N.G., *A New Approach to System Safety Engineering*, MIT, August 2006.
10. NTSB, op. cit., p. 163.
11. USCG, op. cit., Appendix J, "Speech Examination Information," pp. 219-255.
12. Ibid., p. 54.
13. Grove, C., "BLIGH REEF: Lack of crew communication about boat position, course is cited," *Anchorage Daily News*, May 10, 2011. http://www.adn.com/2011/05/10/1855776/report-faults-captain-in-tugboat.html