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Exxon Valdez Oil Spill

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ABSTRACT

On March 23, 1989, the Exxon Valdez crude oil tanker began its journey to Long Beach, California, which would become one of the most monumental marine accidents in the history of the United States of America. Shortly after midnight, just three hours after its departure from the port of Valdez, the vessel ran aground. It had struck a rock formation on Bligh Reef in Prince William Sound, Alaska. The cause of the accident still has some uncertainty to this date, as the ship's captain was unsuccessfully accused of being under the influence of alcohol at the time of the accident, and the ship's third mate failed to return the ship to its designated shipping lane following iceberg manoeuvring. This disaster had significant environmental and economic consequences, but fortunately escaped any human consequences (although there were four deaths associated with the clean-up efforts). An estimated 250,000 to 750,000 barrels of crude oil spilled into the Alaskan waters, a fifth of the entire vessel's storage capacity. Subsequent clean-up efforts lacked the required preparation and experience for such a massive undertaking.

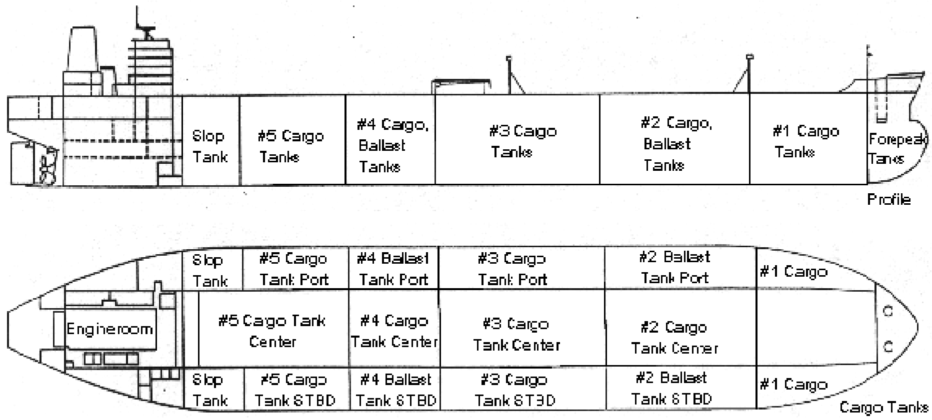
1 INTRODUCTION

The document to follow will describe in detail: the vessel's specifications and purpose, an accident description, estimated consequences of economic and environmental damages, risk control strategies in mitigating the extent of the spill, the impact of the accident on the environment and economy, lessons learned, and ensuing changes to industry codes and practices.

1.1 Vessel Characteristics

The Exxon Valdez was constructed by the National Steel and Shipbuilding Company in 1986 for the purchase by Exxon Shipping Company. At 300 metres long the Exxon Valdez is a rather large vessel, and was the largest vessel[1] constructed on the west coast of the United States of America at the time of the accident. Figure 1.1 below shows the general arrangement of the Exxon Valdez. The ship was certified by the United States Coast Guard and was designed to meet the standards of the 1978 International Convention for the Prevention of Pollution from ships. The ship powers a single five bladed propeller by means of an eight-cylinder, 31650 brake horsepower, reversible, slow-speed Sulzer marine diesel engine.

Figure 1.1: Exxon Valdez General Arrangement



The cargo tanks were spaced apart to protect from high magnitude consequence (i.e. grounding), and to provide stability in the damage condition. The ship was a monohull vessel, of typical welded steel construction.

The vessel was designed for Exxon Shipping Company, and was intended to transport crude oil from the port of Valdez in Alaska to Los Angeles, California, as shown in Figure 1.2. Port Valdez is the farthest reaching ice-free northern port[2] in the United States. As can be seen in Figure 1.3, the port is sheltered inland, making it ideal for access to the Trans-Alaska Pipeline System[3].

Figure 1.2: Route from Port Valdez to Los Angeles

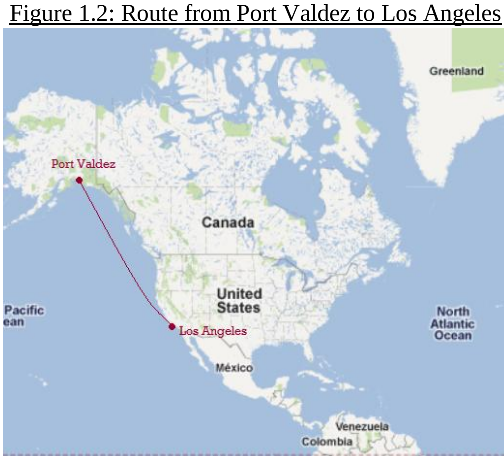
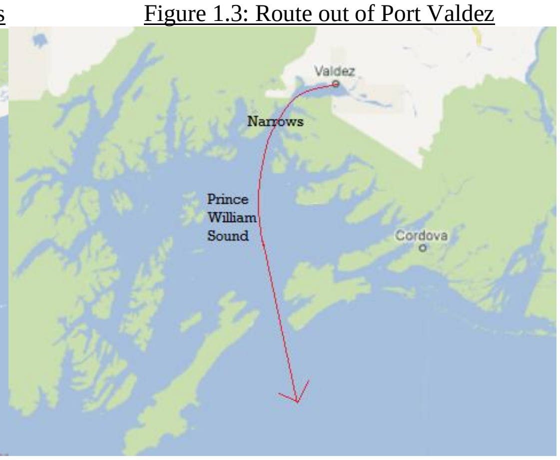


Figure 1.3: Route out of Port Valdez



[1] As taken from the website http://library.thinkquest.org (Exxon Valdez) on November 25th, 2011.
[2] As taken from the City of Valdez website: http://www.ci.valdez.ak.us/port/ on November 25th, 2011
[3] One of the world's longest pipelines, extending from Prudhoe Bay to Valdez.

The route shown in Figure 1.2 and 1.3 provides some interesting challenges for ship navigation as vessels must ensure avoidance of both icebergs and potential grounding. The Bligh Reef has had a history of collisions with vessels.

Today, the Exxon Valdez is still operating, but not under the same name or for its original function. Living on Earth Journalism reports the following timeline of the Exxon Valdez. After the accident, the ship was redeployed to the Mediterranean Sea to continue transporting crude oil under a new name ‘Exxon Mediterranean’. The ship continued to function in the Mediterranean Sea until the early 2000’s, at which point, it was again redeployed to the Middle East and East Asia under the name Dong Fang Ocean. In the mid 2000’s, the ship was converted to an ore carrier, and renamed the Oriental Nicety. Exxon did attempt to return the ship to Prince William Sound shortly after the accident, but was prohibited by law due to its monohull configuration.

1.2 Events Leading to the Grounding of Exxon Valdez

In the following section, a timeline will be described that details as much as possible the events that led to the accident. The following information is a summary of information provided on the Exxon Valdez Oil Spill Trustee Council website.

At the time of departure, the ship’s master, Joseph Hazelwood was in the wheelhouse along with the ship’s third mate Gregory Cousins and the ship’s pilot William Murphy. Shortly after departure (approximately 9:35 PM), Hazelwood left the wheelhouse to return to his cabin. The ship then successfully proceeded through the Narrows (see Figure 1.3) under the supervision of Murphy. Note that it is against Exxon’s company policy to have less than two officers in the wheelhouse while journeying through the Valdez’s narrows.

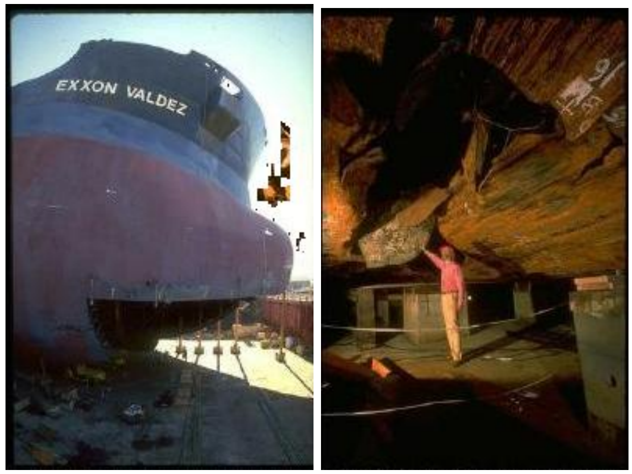
Hazelwood returned to the wheelhouse at 11:10 PM, and changed the heading of the ship in order to avoid potential risk of collision with an iceberg. Murphy then left the wheelhouse upon Hazelwood’s return. Hazelwood did not report the change of heading to the Vessel Traffic Center.

It was also determined that Hazelwood was drinking during the day, prior to departure, and was likely intoxicated at the time of the accident. This was later discredited by the jury due to blood alcohol samples being taken later than three hours after the incident, though Hazelwood did admit to having a few drinks at supper time. Third mate Cousins state of alertness was also in question, as he was covering another mate’s overnight shift with very little sleep.

Human error is considered to be the most significant factor in the cause of this accident. Exxon Shipping Company also came under scrutiny for certain policies. In 2008, Greg Palast[4] wrote “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.” Exxon was also accused of under-manning their vessels, the manning report stated “While Exxon has defended their actions as an economic decision," the manning report says, "criticism has been leveled against them for manipulating overtime records to better justify reduced manning levels.”

[4] As taken from the Greg Palast website: http://www.gregpalast.com (Court Rewards Exxon for Valdez Oil Spill) on November 27th, 2011

Figure 1.4: Resulting Vessel Damage



After the collision with Bligh Reef, the vessel suffered damage in nearly all cargo holds. All cargo holds except for Cargo Hold #5 (see Figure 1.1) suffered severe damage; three salt water ballast tanks were also damaged. Hazelwood kept the engine running until 1:41 AM, more than 90 minutes after grounding.

The National Transportation Safety Board concluded five probable causes of the accident:

(1) The third mate failed to properly maneuver the vessel, possibly due to fatigue and excessive workload;
(2) the master failed to provide a proper navigation watch, possibly due to impairment from alcohol;
(3) Exxon Shipping Company failed to supervise the master and provide a rested and sufficient crew for the *Exxon Valdez*;
(4) the U.S. Coast Guard failed to provide an effective vessel traffic system; and
(5) effective pilot and escort services were lacking

1.3 Subsequent Events of the Grounding of Exxon Valdez

1.3.1 Penalties

According to an article from the Encyclopedia of Earth, Exxon Shipping Company was fined $150 million for environmental crimes, $100 million for restitution of environmental damages, $900 million for restitution of resources. The company also paid $2.2 billion for cleanup expenses, and $1 billion for settlements with the state and federal governments. Captain Hazelwood was fined $50,000 and ordered to serve 1000 hours of community service.

1.3.2 Resulting Influence on Ship Design Codes and Standards

There are many important lessons to be learned from the Exxon Valdez oil spill. One of the most important is the relatively high risk associated with single hull tankers. Today, there are very few single hull oil tankers that are permitted to access North American and European ports. Most oil tankers are required to have a double hull, or at least a double bottom. Meaning, there is a second outer shell surrounding the hull of the vessel with sufficient spacing between the outer and inner shells. After the accident, the Exxon Valdez was no longer permitted to operate in Alaskan waters. The following information is from Europa (Summaries of EU Legislation), 2011:

> Following the *Exxon Valdez* accident in 1989, the United States (US), dissatisfied with the ineffectiveness of the international standards on the prevention of pollution from ships, adopted an Oil Pollution Act in 1990 (OPA 90). This act unilaterally imposed double hull requirements on both new and existing oil tankers. Faced with this unilateral measure on the part of the Americans, the International Maritime Organisation (IMO) had to take action and established double hull standards in 1992 in the International Convention for the Prevention of Pollution from Ships (MARPOL).

Many countries and international standards are currently phasing out the use of single hull tankers. It is not an easy task to eliminate a significant number of tankers from the oil and gas industry, so it has been a relatively slow process since the accident occurred. If single hull tankers were to become obsolete instantaneously, there would be a significant economic strain on oil and gas companies, the shipping industry, and the economies that they influence.

1.3.3 Exxon Valdez

As discussed in Section 1.3.2, the Exxon Valdez was banned from Alaskan waters after the oil spill. For a decade, the supertanker continued to operate in European waters until the mid 2000's, at which time, it was converted to an iron ore carrier and continues to operate in East Asian waters under the name Oriental Nicety.

1.3.4 Resulting Change by Operator

Shortly after the Exxon Valdez oil spill, the operator of the vessel (Exxon) developed a new system called Operations Integrity Management System (OIMS). ExxonMobil goes on to state, "Our commitments are documented in our safety, health, environment and product safety policies. The Operations Integrity Management System, or OIMS, provides the strategic direction for meeting that commitment... The managers of our businesses are responsible for ensuring that systems are in place to satisfy the company's safety, health and environmental expectations... In 1998, Exxon elected to measure OIMS against this voluntary ISO benchmark. After their independent assessment, Lloyd's Register Quality Assurance Ltd. (LRQA) attested that OIMS meets ISO 14001 requirements." An ExxonMobil employee goes on to further state "After the Exxon Valdez oil spill, Exxon recognized a need to develop a better process for ensuring the safety, health and environmental aspects of their projects and operations. Thus, OIMS was developed." (Subsea Equipment Contract Lead, 2011)

1.4 Economic Consequences

The ensuing clean up from this accident lasted years, and the environmental effects are still felt today, thus there are still costs incurred by governments today. In addition to the expenses incurred by Exxon (Section 1.3.1), the courts fined Exxon $5 billion in punitive damages. Exxon has appealed this case many times, by 2007 the fine had been dropped to $2.5 billion, and again reduced to just $500 million the following year. The LA Times report "The Supreme Court on Wednesday brought to a close the 19-year legal battle over the Exxon Valdez oil spill by sharply reducing the punitive damages to be paid by Exxon Mobil Corp. The court ruled that the oil giant must pay $507 million... The justices described Exxon's conduct as "worse than negligent but less than malicious."" (Savage, 2008).

The economic consequence of this oil spill also extends to various other activities; however these are significantly more difficult to assign a monetary value. To this day, the Prince William Sound environment is not the same as it once was. Tourism, recreational sport fishing, fishing industry, replacement costs of birds and animals, are all considered economic losses caused by the Exxon Valdez oil spill.[5]

1.5 Environmental Consequences

Figure 1.5: Extent of Valdez Oil Spill

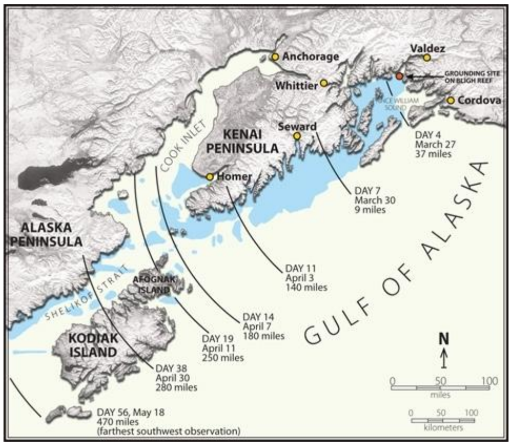


Figure 1.5 shows the extent of the Exxon Valdez oil spill just two months after the accident. Environmental consequences were worsened due to the close proximity to the shore. Rocky and jagged shorelines made ensuing clean-up efforts extremely difficult, and caused further damage to marine wildlife. The spill area is estimated to cover over 11,000 square miles and 1300 miles of coastline.

The Oceana North American website reports the following environmental impacts:

- As many as 2,800 sea otters, 300 harbor seals, 900 bald eagles and 250,000 seabirds died in the days following the disaster.
- Twelve years after the spill, oil could still be found on half of the 91 randomly selected beaches surveyed
- Three species of cormorant, the common loon, the harbor seal, the harlequin duck, the pacific herring and the pigeon guillemot still have not fully recovered.
- Pink salmon embryos continued to be harmed and killed by oil that remained on stones and gravel of stream banks through at least 1993. As a result, the southwestern part of Prince William Sound lost 1.9 million or 28 percent of its potential stock of wild pink salmon.
- 1,000 harlequin ducks were killed by the oil spill, in addition to many chronic injuries that occurred as a result of the long term effects of the spill.

The environmental consequences that followed the Exxon Valdez accident are clearly extremely high. In 2004, the National Geographic reported that the Exxon Valdez oil spill is outside the top 50 largest oil spills by volume, but that it may have caused more environmental damage than any other oil spill. It is not the volume of oil that led to such high environmental consequences, but rather the remote location, populous wildlife, lack of preparation by Exxon, and insufficient clean-up methods that led to such extreme environmental damages. For comparison, the Exxon Valdez spilled 11 million gallons of oil into Alaskan waters, which is relatively small when compared to the 140 million gallons of oil

[5] As taken from the Encyclopedia of Earth website: http://www.eoearth.org/article (Exxon Valdez Oil Spill) on November 27th, 2011

released from the Ixtoc 1 in 1979[6]. The fact that this spill occurred in a sound, as opposed to an open ocean certainly attributes to the extent of the environmental consequences.

2 RISK CONTROL STRATEGIES

2.1 Established Plans

In the event of an oil spill, the United States government has established a National Response System for dealing with oil discharges and hazardous waste[7]. This plan, along with other contingency plans (regional, Prince William Sound plan, Ayleska plan, Exxon plan) provided the basis for assigning responsibilities and actions associated with the clean-up. The Ayleska Pipeline Service Company represents multiple oil companies in the state of Alaska, including Exxon. The Exxon plan for dealing with oil spills, though not required by law, was not particularly effective as it gave no details specific to the Exxon Valdez, Prince William Sound, Alaska, or Ayleska. Essentially, the Exxon plan was a general guideline for coping with oil spills.

The National Response Team found that the resources, training, communications, and clean-up methods used were not sufficient for the severity of such an oil spill.

2.2 Clean-Up Method

Methods of removing oil from the Prince William Sound can be separated into three categories: burning, mechanical clean-up, and chemical dispersants.

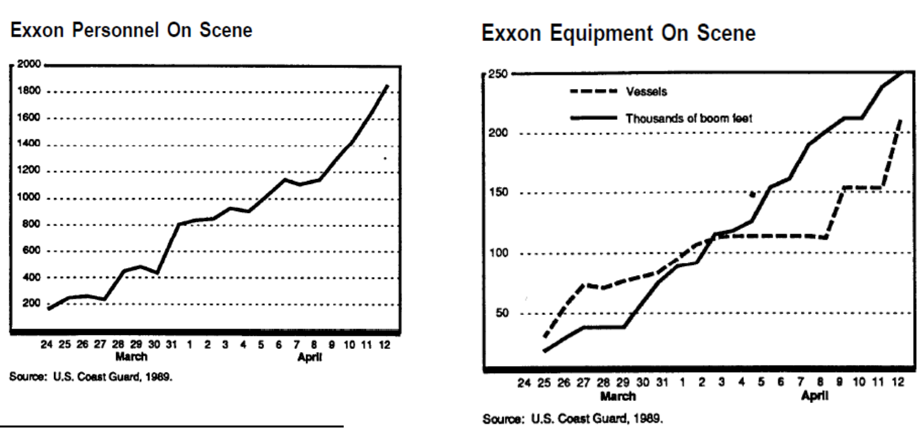
Burning: Two ships towed oil away from the scene by a boom connected to tow lines. Once the oil was a safe distance away from the main slick and the Exxon Valdez, the oil was ignited.

Mechanical Clean-Up: Booms and skimmers were used to remove oil from Prince William Sound.

Chemical Dispersants: Dispersants were applied to the oil slick, but were deemed ineffective as the weather did not permit mixing of the dispersant.

Shortly after the accident, personnel were mobilized by Exxon Shipping Company, the U.S. Coast Guard, and federal agencies. The graphs below depict a timeline of the number of Exxon personnel and equipment involved with the clean-up.

Figure 2.1: Exxon Personnel and Equipment on Scene



[6] As taken from the Greenpeace website: http://www.greenpeace.org/usa (Ixtoc Blowout - 31 Years Ago Today)
[7] Provided by the National Response Team, in the Exxon Valdez Oil Spill – A Letter to the President document

In a report to the president, prepared by the National Response Team, the following aid details are provided. By April 12th, the Federal Government had provided 25 vessels, 30 skimmers, and 500 personnel to aid on the clean up. Exxon also provided 70 skimmers on scene, in addition to its 200 vessels.

2.3 Lessons Learned

Figure 2.2: High Pressure Water

Applying high pressure hot water to oil covered rocks on the shoreline was later found to have likely caused more harm than good. The method not only removed the oil from any rocks, but created a barren and inhabitable shoreline. "Full scale hot water washing became the standard shoreline treatment of EVOS oiled beaches in June of 1989 but after only six weeks of use it was creating controversy because hot water washing is extremely harsh on beaches. It literally cooks all the life leaving a bare, dead shoreline." (ThinkQuest, 2009).

In 2011, the U.S. Environmental Protection Agency stated, "Alyeska had less than 4,000 gallons of dispersant available in its terminal in Valdez, and no application equipment or aircraft... Because there was not enough wave action to mix the dispersant with the oil in the water, the Coast Guard representatives at the site concluded that the dispersants were not working and so their use was discontinued." Personnel from the U.S. Coast Guard and federal agencies were quickly on scene aiding to the clean up. The Environmental Protection Agency also goes on to say that adequate resources were not provided for the clean-up effort. Skimmers were also not immediately available. And though they may be one of the most effective clean-up methods today, they encountered numerous repair problems due to the thick oil and kelp.

2.4 Potential Loss Prevention

The most appropriate method for removing spilled oil is of course, to not have an accident in the first place. The following points are suggestions that may have prevented the Exxon Valdez oil spill or lessened the severity of it:

- All supertankers should be constructed with a double hull, this may not have entirely prevented the accident, but likely would have lessened the extent of the spill.
- Exxon received criticism for under manning their vessels, and within the three hours of the Exxon Valdez's last departure from the port of Valdez there were at least two counts of only one officer manning the wheelhouse (against company policy). Exxon should have developed a plan to ensure that officers are not frequently breaking their policies, or at the very least, a method of determining whether the officers are following their policies.
- Overtime hours should also be restricted, and personnel should not be permitted to cover another mate's shift if it means working overtime. Extra personnel would also reduce overworking the crew in the event of overtime hours and sick leave.
- All instrumentation that assists the safety and navigational ability of a ship should be immediately repaired and checked to ensure quality of operation.

3 CONCLUSION

Though the Exxon Valdez oil spill was not the world's largest oil spill, it certainly could have caused the most environmental damage. Risk is associated with the product of the probability of failure and its associated consequences. In this case, the environmental consequences of an accident were extremely high. Since this was a high risk operation, detailed plans should have been in place to deal with a worst case scenario event. Exxon should have recognized that an accident in the Prince William Sound, could lead to devastating consequences. Human error is likely the cause of this accident, and continues to be an issue with all technological systems, but that is not an excuse for not providing adequate resources, plans, methods, and training in the event of an accident.

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