OCS Report
MMS 89-0102

Investigation of Amoco Pipeline Company High Island Pipeline System Leak Galveston Block A-2 February 7, 1988

Gulf of Mexico
Off the Texas Coast

MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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by
Don Howard
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Alex Alvarado
Clifford Kirkpatrick

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

New Orleans
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Investigation and Report

Authority

The following investigative panel of Minerals Management Service (MMS) personnel was given the assignment to investigate and to prepare a public report on the pipeline leak that occurred approximately February 7, 1988, at Galveston Block A-2, off the Texas coast:

Don Howard	Paul Schneider
Alex Alvarado	Clifford Kirkpatrick

The panel members were named by memorandum dated February 11, 1988, pursuant to Section 208 (subsections 22d, e, and f) of the Outer Continental Shelf (OCS) Lands Act (amended, 1978).

Procedures

The MMS accident investigation panel members met at the Minerals Management Service Gulf of Mexico OCS Regional Office in New Orleans, Louisiana, April 26, 1988, through April 27, 1988. The panel chairman, Mr. Don Howard, presented a comprehensive account of the incident. Each member then presented and discussed information he had gathered as a result of his investigation. The chairman considered all the facts and data presented and then determined additional information was needed from the Amoco Pipeline Company and the MMS Surface Commingling and Production Measurement Section. The additional information was obtained on the afternoon of April 26, 1988.

Introduction

Background

Amoco Pipeline Company is the pipeline right-of-way (ROW) holder and/or operator of MMS Royalty Measurement Pipeline System 1.5, which gathers liquid hydrocarbon produced from Federal oil and gas leases in the High Island and East Breaks areas. The product is delivered onshore to Amoco Pipeline Company's metering facility at its Texas City, Texas, terminal. Offshore sales points for royalty purposes are established at the Federal oil and gas lease injection points. The onshore metering facility only provides onshore delivery measurement data to the pipeline operator.

The leak involved a 14-inch segment of the High Island Pipeline system. The ROW for this pipeline segment extends 57 miles from High Island Block A-474 Platform A to the Federal-State boundary line in Galveston Block 214. From this point the pipeline continues 36 miles across State waters to Amoco Pipeline Company's terminal in Texas City, Texas (see attachment). The ROW was approved on February 24, 1978, under 30 CFR 256 regulations. Operational regulation of the line is in accordance with the Department of Transportation Regulation 49 CFR 195 — Transportation of Hazardous Liquids by Pipeline.

Description of Incident

Each morning at approximately 7:00 a.m., the Amoco Pipeline Company calculates the volume of oil delivered to the pipeline system offshore and compares that with the volume received at the

onshore terminal at Texas City. This comparison is accomplished by using the System Control and Data Acquisition (SCADA) program. A remote, computerized system, SCADA monitors and compares system volume input and output.

On the morning of February 8, 1988, the calculations showed an unusual shortage of oil at the terminal. A helicopter was immediately dispatched to patrol the pipeline route to determine if there was a leak. The pilot discovered an oil spill in Galveston Block A-2 (see attachment for location) at 8:45 a.m. He radioed Amoco Pipeline Company's Texas City office, and the pipeline system was remotely shut down in an orderly fashion by 9:45 a.m., February 8, 1988.

Cal-Dive International in Morgan City, Louisiana, was contracted by Amoco Pipeline Company from February 9, 1988, through February 15, 1988, to locate and repair the leak in the 14-inch pipeline. High seas ranging from 3 to 14 feet prevented Cal-Dive from beginning repair of the pipeline until February 12, 1988. Divers located approximately 110 feet of disturbed pipeline (normally buried 3 feet below the mud line) elevated to a maximum height of 8 feet above the natural bottom. Near the center of the disturbed area was a damaged section of exposed pipe approximately 6 feet long with missing portions of concrete and mastic coating. The pipe was dented and flattened at the 6 o'clock position and had a horizontal crack along the pipeline axis at the

3 o'clock position in the pipe wall. The pipe also had markings on it that indicated external physical contact with a foreign object. The divers recorded the damaged section on film before cutting out and replacing a 40-foot section by installing Gripper-type connections with ball joint flanges on the ends. The pipeline was then reburied 3 feet below the mud line and returned to service at 8:00 a.m. on February 13, 1988.

The total shut-in time was 118 hours and 15 minutes. Amoco Pipeline Company's repair costs were approximately $20,000 per day for the diver crew and over $100,000 for the "Gripper" repair system. Throughput loss for 5 days was approximately 325,000 barrels (bbl).

Oil-Spill Observation Reports

February 8, 1988

An oil slick was first observed in the vicinity of the pipeline by Amoco at 8:45 a.m. Amoco estimated the slick to be 15 to 20 miles long and 1 to 3 miles wide. Dark brown streaks were observed near the apparent origin of the leak followed by a dark sheen for 5 to 6 miles and a light sheen for the remainder. The slick was located at 29°29'N. latitude and 94°35'W. longitude, 30 to 40 miles southeast of Galveston, Texas, and was moving westerly. At the scene, Amoco reported winds from 70°N at 10 knots, 6- to 8-foot seas, 5 miles visibility, a temperature of 70 °F, and a 500-foot ceiling.

At 2:00 p.m. the same day, MMS technicians reported the slick to be brown in color, 5 to 6 miles long and 1/2 mile wide. The slick appeared to be moving west-southwest parallel to the coast and was breaking up.

February 9, 1988

Amoco reported the slick was located at 28°49'N. latitude and 94°35'W. longitude and appeared to be on a course of 240°. The slick was 245 feet long and 26 feet wide and was breaking up into a dark sheen. Amoco reported winds at the scene at 15 knots, seas 3 to 5 feet, and a 500-foot ceiling.

February 10, 1988

There were no observations made on this date due to inclement weather.

February 11, 1988

Evidence of the oil slick could not be located. Amoco reported winds at 40 knots and 10- to 14-foot seas.

Analysis of System Receipts and Deliveries and Leak Detection

Amoco performs a daily detailed analysis of the volume of oil reaching the main sales meter onshore. This volume is compared with the input volumes measured during that period at each Lease Automatic Custody Transfer meter on the producing platforms in the system. On February 8, 1988, the daily 7:00 a.m. analysis revealed an initial volume imbalance (a shortage) of 13,617 bbl.

This prompted Amoco to investigate the cause, and an overflight of the pipeline was conducted. An oil slick was discovered in the vicinity of the pipeline ROW. Amoco, assuming a leak had occurred, shut in the pipeline.

Failure Analysis

Photographs and the underwater video of the damaged section of pipe showed the crack was caused by pipe deformation, which possibly occurred when a snagged anchor lifted the pipe up to 8 feet off the bottom. The crack was located on the east side of the pipe at the 3 o'clock position and was approximately 6 inches long by 1/4 to 3/8 of an inch wide. Inspection of the damaged section of pipe onshore and of the photographs and video of the pipeline in place showed no corrosion, which indicated that the pipeline had been damaged recently.

Leak Rate Determination

Amoco Pipeline Company's office in Texas City gathers transmitted information each morning from all platforms feeding the High Island Pipeline System. Receipts and deliveries are compared in order to determine any abnormality indicating a leak in the system.

On the morning of February 8, 1988, a preliminary check of computer data revealed a loss of 13,617 bbl of 38.9°API gravity oil. Subsequent to the repair of the leak, an "over/short" summary study of the month's production indicated that 15,576 bbl were lost due to the leak. This amount was analytically verified by the panel.

The size of the rupture, the water depth, and the calculated pipeline pressure at the point of rupture were used in the computations.

Possible Oil-Spill Volume

The analysis of the SCADA system, supported by analytical leak rates, indicated to Amoco Pipeline Company that a spill of this size was possible during the time period from 7:00 a.m., February 7, through 7:00 a.m., February 8, 1988.

Panel Investigation and Findings

The MMS panel members independently investigated the following aspects of this incident:

- System measurement balance data. These data were supplied by Amoco Pipeline Company's SCADA system for the period of February 1, 1988, through February 21, 1988.

- Oil-spill reports to the U.S. Coast Guard and MMS during the period of February 7, 1988, through February 12, 1988, for the leak-affected area.

- Production Accounting and Auditing System data in the Oil and Gas Operations Report, as reported by the designated lease operators of the leases where production enters the 1.5 System (High Island Gathering System).

- Pressure-flow calculations of the pipeline leak.

- Onshore inspection of the damaged section of pipe.

- Photographic evidence (video and print) of the affected section of the pipeline in its subsea and onshore locations.

- The surface spill path using U.S. Coast Guard siting data and local meteorological data of the prevailing weather conditions during the time of the leak.

System Measurement Balance

The following table (using information provided by Amoco) lists the actual over/(short) volumes recorded at 7:00 a.m. from February 1, 1988, through February 17, 1988.

Over/(Short) Volume in Barrels

Date	Daily (bbl)	Cumulative (bbl)
02-01-88	(999.12)	(999.12)
02-02-88	991.12	(8)
02-03-88	(137)	(145)
02-04-88	(118)	(263)
02-05-88	234	(29)
02-06-88	(358)	(387)
02-07-88	(630)	(1,017)
02-08-88	(13,617)	(14,634)
02-09-88	(1,131)	(15,765)
02-10-88	0	(15,765)
02-11-88	0	(15,765)
02-12-88	0	(15,765)
02-13-88	0	(15,765)
02-14-88	0	(15,765)
02-15-88	(828)	(16,593)
02-16-88	23	(16,570)
02-17-88	84	(16,486)

The large discrepancy on February 8, 1988, prompted Amoco to investigate the high probability of a leak in the pipeline. Aircraft surveillance revealed an oil slick in the vicinity of the pipeline, and the system was shut down. Divers later confirmed a leak. The system was repaired and returned to service on February 15, 1988.

Oil-Spill Reports and Spill Trajectory

Almost all available oil-spill research and models relate to surface spills and not subsurface spills such as this one. In the case of subsurface spills, not all of the oil may reach the surface. This

condition was true for the Ixtoc blowout for which, however, no statistics are available. By using data from MMS Study 85-0105 *Oil Slick Sizes and Length of Coastline Affected* (August 1985), the spill volume was estimated from the observed slick sightings.

1 mi x 15 mi slick = or approximately	10,000 bbl
3 mi x 20 mi slick	152,000 bbl

When these estimates are applied to the turbulent sea state and streaking effects, Amoco's estimate of approximately 15,000 bbl appears reasonable.

Analytical Pipeline Leak Model

The pipeline operating pressure at Platform A, High Island Block A-474, ranges from a high of 1,228 pounds per square inch (psi) to a low of 855 psi with an average operating pressure of 1,075 psi. The average pipeline pressure at the onshore terminal is 25 psi. The pipeline high- and low-pressure sensors on Platform A were set at 1,350 psi and 770 psi, respectively. Since the leak occurred approximately at the halfway point (46 miles from the shore facility), the pipeline pressure was estimated to be 525 psi at the leak point. If the hydrostatic head pressure at the leak location is considered, the pipeline pressure is estimated at 492 psi. Flow calculations were made to determine the minimum time required for the reported volume of spilled oil to flow through the opening, which is assumed to be 6 by 3/8 inches or 0.0156 square feet. This time was estimated to be 5 hours, assuming no friction loss at the opening.

Consideration of Factors Affecting the Surface Appearance and Observation of Leaked Oil

Once a spill occurs and a surface slick is formed, there are a number of physical, chemical, and biological processes that can alter the original mixture of the oil components.

The two major processes that affect the spilled oil volume are evaporation and dispersion. Studies have shown that up to two-thirds of the original oil volume may be lost due to evaporation and dispersion in a period of time from a few hours to a day.

In addition to the two major factors affecting the surface appearance of an oil slick, other factors must be considered in estimating a volume of oil spilled. These include slick thickness, oil-water interfacial tension, sea state, the amount of particulate matter in the water column, and the number of days from the beginning of the spill to the time the slick size was estimated. All these factors can be considered in estimating the volume of oil spilled for a given-size oil slick. However, this estimate would be only for the oil that appeared on the surface of the water. There is evidence, as shown in studies of the Ixtoc oil spill, that not all subsurface-released oil will appear on the water surface. Oil plumes were shown to remain in the water column for periods of time. Furthermore, it was shown that subsurface plumes do not necessarily move in the same direction as surface plumes.

Conclusions

The reported spill volume of 15,576 bbl, which was obtained from daily readings of receipts and deliveries, could have leaked from the opening in the pipeline during a period of less than 24 hours. Any attempt to estimate the total amount of oil spilled based on visual observations of the reported slicks would result only in a gross estimate of the amount of oil found in the reported slicks. This amount could not be used to obtain an estimated spill volume with any degree of validity.

The operating pipeline pressure at the departing platform ranged from a high of 1,228 psi to a low of 855 psi. The high- and low-pressure sensors were set at 1,350 psi and 770 psi respectively. At the time of the leak, the pipeline operating pressure was 1,050 psi. The size of the leak was not large enough to drop the operating pressure below 770 psi, thus activating the low-pressure sensor that would have shut-in the pipeline.

The SCADA system is not required under MMS regulations but was useful in detecting and measuring the leak during normal operating conditions. Without the SCADA system, the leak could have gone undetected for a longer period of time, since the safety equipment and pressure sensors on High Island Block A-474 Platform A did not detect this leak due to the minor pressure drop caused by the 6 by 3/8-inch crack in the pipeline.

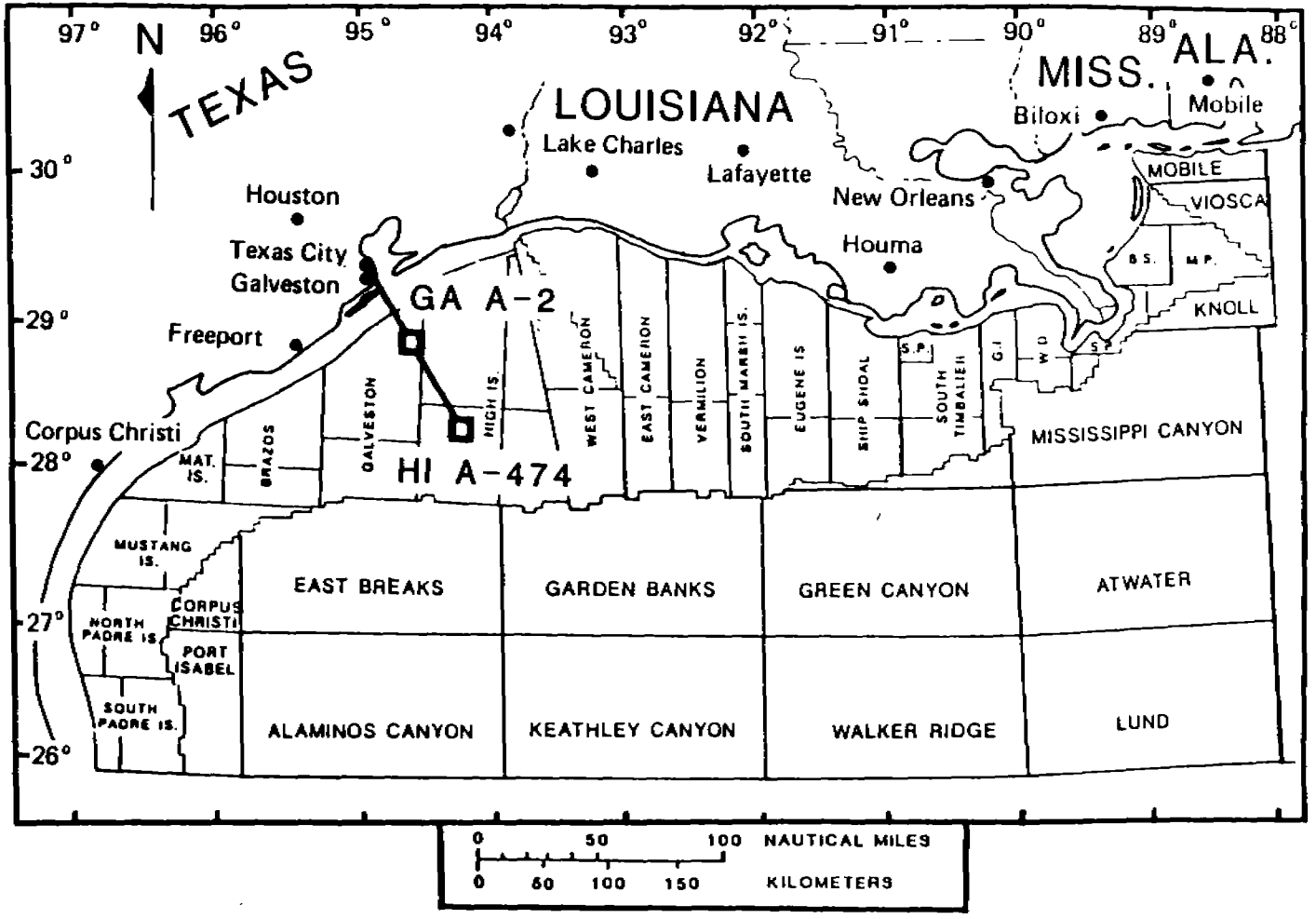
From the onshore inspection and review of land photographs, underwater video, and the divers' report, it was determined that the pipeline damage was probably caused by an anchor snagging the pipeline and subsequently being freed. This incident, which occurred outside of any designated anchorage area, was unpredictable and unavoidable from the pipeline operator's standpoint.

Recommendations

The SCADA system should be balanced more frequently than once each day in order to detect possible pipeline leaks more quickly and reduce the amount of oil spilled.

National Ocean Service nautical charts should be updated as to the location of pipelines.

The MMS Gulf of Mexico OCS Region should investigate the applicability of pipeline leak detection systems, other than low-pressure sensors, for use in the Gulf of Mexico.



Pipeline route showing location of originating point in the High Island Area Block A-474 (HI A-474), and where pipeline damage occurred in Galveston Block A-2 (GA A-2). Index map showing Outer Continental Shelf and Slope leasing areas off Texas, Louisiana, Mississippi, and Alabama.