ABSTRACT

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Title: EPA's inland oil spill prevention regulations and review of oil spill incidents reported to the National Response Center from onshore oil production facilities

Abstract: The paper discusses considerations for prevention requirements under the Spill Prevention, Control, and Countermeasure (SPCC) regulation (40 CFR part 112) of onshore oil production facilities. The paper summarizes findings from a recent review of oil spill incidents reported to the National Response Center (NRC) during the period of 2000 through 2005.

The analysis covers the relative frequencies and magnitudes of reported oil discharges from onshore oil production facilities by material discharged, source, and cause.

EPA's inland oil spill prevention regulations and review of oil spill incidents reported to the National Response Center from onshore oil production facilities

by

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1. Introduction

The petroleum exploration and production (E&P) industry sector is one of many sectors regulated under the Spill Prevention, Control, and Countermeasure (SPCC) regulation at 40 CFR part 112. In the SPCC rule, EPA defines a production facility as:

> *"All structures (including but not limited to wells, platforms, or storage facilities), piping (including but not limited to flowlines or gathering lines), or equipment (including but not limited to workover equipment, separation equipment, or auxiliary non-transportation-related equipment) used in the production, extraction, recovery, lifting, stabilization, separation, or treating of oil, or associated storage or measurement, and located in a single geographical oil or gas field operated by a single operator." (40 CFR 112.2)*

The original Oil Pollution Prevention regulation (better known as the Spill Prevention, Control, and Countermeasure (SPCC) rule) was promulgated in December 1973 and became effective in January 1974.[1] Following CWA section 311(j)(1)(C) and the jurisdictional definitions in the EPA-DOT MOU, the regulation established oil discharge prevention procedures, methods, and equipment requirements for non-transportation-related facilities. The main thrust of the rule is the requirement for facilities to prepare a Professional Engineer (PE)-certified plan outlining their spill prevention methods. The applicability of the SPCC rule is closely related to the reporting requirement for harmful discharges to navigable waters (40 CFR part 110). Thus, the owner or operator of a non-transportation-related facility is not required to develop an SPCC Plan if the facility, because of its location, could not reasonably be expected to discharge a reportable quantity of oil into navigable waters or adjoining shorelines. The scope of the regulation covered facilities with an aboveground (non-buried) oil storage capacity greater than 1,320 gallons (or greater than 660 gallons aboveground in a single tank) or a buried underground oil storage capacity greater than 42,000 gallons. The rule applies to the use, handling or storage of all types of oil, including non-petroleum oils, and regulates a very wide range of facilities throughout the exploration, production, refining, storage and end use processes.

The 1974 rule included sections on general applicability, relevant definitions, the requirement for preparation of SPCC Plans, provisions for SPCC Plan amendments, civil penalty provisions, and requirements for the substance of the SPCC Plans. An important aspect was the requirement for a registered Professional Engineer (PE) to review the SPCC Plan and certify that it was prepared in accordance with good engineering practices.[2] Since the SPCC Plan does not need to be submitted and approved by regulatory authorities, the

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[1] 38 FR 34164, December 11, 1973.

[2] 40 CFR 112.3(d). 38 FR 34166, December 11, 1973.

PE acts as an independent agent in ensuring that the site-specific measures implemented by the facility are environmentally protective and conform to good engineering practices.

Consistent with the FWPCA, the goal of the SPCC rule is to prevent all discharges of oil in quantities that may be harmful. In developing the rule, EPA recognized the wide range of regulated facilities, and that to achieve its goal, "no single design or operational standard can be prescribed for all non-transportation-related facilities, since the equipment and operational procedures appropriate for one facility may not be appropriate for another because of factors such as function, location, and age of each facility."[3] The minimum set of requirements for an SPCC Plan included fundamental and professionally accepted engineering practices that had shown a high degree of success in preventing spills. These requirements were originally called "guidelines" and were written in a way so as to "give the engineer preparing the Plan greater latitude to use alternative methods better suited to a given facility or local conditions."[4] For example, among the requirements for drainage water treatment found in §112.7(e)(1)(v), requirements for lift pumps were specified for certain circumstances. The provision ended, "In any event, whatever techniques are used, facility drainage systems should be adequately engineered to prevent oil from reaching navigable waters in the event of equipment failure or human error at the facility." This allowed the Plan preparer and PE certifying the Plan the flexibility to determine what type of pumps or facility drainage systems are best suited to the particular facility. Other provisions also provided suggested alternative methods of design. For example, §112.7(e)(3) describes requirements for buried piping installations, "An alternative would be the more frequent use of exposed pipe corridors or galleries." (38 FR 34168, December 11, 1973).

As noted in the preamble to the 1973 proposal, "This approach places responsibility on the owner or operator … to identify effective methods, procedures, and equipment requirements to prevent oil spills."[5] The preamble further notes, however, that the owner/operator must incorporate these items into a Plan that conforms with the minimum standard guidelines contained in the regulation or with state regulations, whichever are more stringent.

Although the SPCC rule provides specific requirements for different types of E&P facilities, (e.g., onshore facilities, workover facilities, offshore facilities), this paper focuses on the spill incidents associated with onshore oil production facilities.[6]

This paper summarizes a review of recent spill history from onshore oil production facilities undertaken by EPA. In comments submitted to EPA, representatives of the E&P sector have raised specific concerns about SPCC requirements as they apply to produced water containers and facilities that produce from marginal wells. "Produced water" is the oil-water mixture left over after the marketable crude oil is separated from the fluid extracted from the geological formation, and tends to contain significant quantities of oil – often in the range of 1 to 10 percent of oil by volume or greater. "Marginal wells" are wells that produce 10 barrels of oil or less per day.[7] This review aimed to characterize oil discharges reported

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[3] 38 FR 34164, December 11, 1973

[4] 38 FR 34165, December 11, 1973

[5] 38 FR 19334, July 19, 1973

[6] The SPCC rule provides specific requirements for different types of E&P facilities, including: onshore oil production facilities (§112.9), onshore oil drilling and workover facilities (§112.10), and offshore oil drilling, production, or workover facilities (§112.11).

[7] Alternate definitions of marginal or stripper wells set the production thresholds to 15 barrels of oil per day or less.

from onshore oil production facilities, including discharges of produced water and discharges from facilities that produce from marginal wells, to inform the evaluation of appropriate spill prevention measures for these facilities as EPA considers potential amendments to the SPCC rule.

In the remainder of this paper, we summarize the methodology (Section 2.1) used to select relevant oil discharges. We then discusses results of EPA's review of national (Section 2.2) in terms of the overall number of incidents and spilled volumes. In Section 2.3, we further characterize oil discharges from onshore in terms of spill sources and causes, highlighting implications for evaluating spill prevention measures. We highlight the limitations of the analysis in Section 3, and offer conclusions from the available data in Section 4.

2. Spill History

Federal environmental regulations require that oil discharges to navigable waters or adjoining shorelines be reported to the National Response Center (NRC) (40 CFR part 110).[8] Many states have additional reporting requirements for oil discharges, including, in some cases, requirements to report discharges to land or groundwater. This section summarizes oil discharge data for the production sector collected from a variety of sources, including federal, state and other databases. Characteristics of these oil discharges – e.g., frequency, volume, geographical distribution, source, and cause – are discussed.

2.1. Methodology

EPA collected data from the National Response Center (U.S. Coast Guard), a national-level data source. The raw data EPA considered covers the six-year period from 2000 through 2005, and consists of individual records describing each discharge incident. The data fields generally include, at a minimum, the incident date, material spilled, name of the suspected responsible party, the source and cause of the discharge, the estimated volume discharged, and a description of the discharge circumstances, although not all fields may be populated for all discharge incidents.

Appendix B to this paper details the methodology applied to select, classify, and analyze spill incident records. In general, the methodology involved reviewing each individual record to determine, based on the material(s) involved, equipment source, responsible party, and incident description, whether the incident could reasonably be attributed to an onshore oil production facility. The steps involved first selecting reported incidents that involved crude oil, saltwater/brine, produced water, or a combination of these materials, and for which the NRC source category was not a vessel, platform or railroad. The incident description was then reviewed to determine whether the equipment mentioned in the incident report was production-related. Examples of production equipment included wellhead, tank battery, separator, gun barrel, heater-treater, stock tank, water tank, flowline, and gathering line. Incidents that appeared to have originated from offshore production facilities (e.g., equipment found on platforms or spills originating from oil fields located in the Gulf of Mexico) were excluded from the selected spills data.

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[8] 40 CFR part 110 states: "Any person in charge of a vessel or of an onshore or offshore facility shall, as soon as he or she has knowledge of any discharge of oil from such vessel or facility in violation of section 311(b)(3) of the Act, immediately notify the National Response Center (NRC)…" (§110.6), and further "For purposes of section 311(b)(4) of the Act, discharges of oil in such quantities that the Administrator has determined may be harmful to the public health or welfare or the environment of the United States include discharges of oil that: (a) Violate applicable water quality standards; or (b) Cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines." (§110.3)

We then classified each relevant incident according to the source of the discharge within the production facility, and the cause. This classification was based on the source and cause information recorded by the data provider and/or on our interpretation of the incident description. Possible source and cause categories are presented in Exhibit 1.
A number of the sources of oil discharges listed in Exhibit 1 are associated with produced water, including but not limited to, tanks (produced water tank, and other or unspecified tank type), tank batteries, and water disposal systems. It is not always possible to identify the exact type of oil that is involved in a reported spill. Some discharge incidents reported as originating from tanks specified to be produced water tank are reported as crude oil discharges. Other NRC spill incidents are described specifically as involving produced water or mixtures of oil and produced water but as originating from containers of unspecified characteristics.

Exhibit 1. Discharge Source and Cause Categories (listed in alphabetical order).

Source
▪ Appurtenance (valve, transfer pump, or other component)
▪ Flowline
▪ Gathering system
▪ Other component
▪ Separation equipment (e.g., separator, gun barrel, heater-treater)
▪ Tank (crude oil)
▪ Tank (produced water)
▪ Tank (other or unspecified tank type)
▪ Tank battery (other or unspecified component of tank battery)
▪ Unknown or unspecified source
▪ Water disposal system (injection lines, injection well)
▪ Wellhead (pumping jack, well casing, valves at wellhead)
Cause
▪ Accidental impact (e.g., collision with vehicle, digging equipment)
▪ Cattle interference
▪ Corrosion
▪ Equipment failure, not otherwise specified
▪ Leak, hole, or rupture (may be corrosion-related)
▪ Natural phenomenon (hurricane, heavy wind, flood)
▪ Operator error (e.g., valve left in wrong position)
▪ Overfill
▪ Other cause
▪ Unknown / unspecified
▪ Vandalism

2.2. National Overview of Oil Discharges from Onshore Oil Production Facilities

2.2.1. National Summary

The review of the NRC data for the six-year period of 2000 through 2005 identified a total of 3,007 individual spill incidents that can positively be attributed to onshore oil production facilities.[9] Materials involved in these incidents included crude oil, produced water, and mixtures of production fluids. The NRC database provides information on the estimated volume involved in 2,532 of these discharges. Additionally, 1,260 of these production-related incidents are specifically identified by NRC as having impacted “waters,” as reported by the individual making the notification. The NRC database does not provide information on

[9] The number of incident records contained in the data set selected from the NRC database was 3,023; of which 3,007 records referred to unique incidents, and 16 records had more than one substance released for the same incident. For these later incidents the volume discharged for the incident was calculated as the sum of the volumes for each substance discharged, when volumes were provided.

impacts to water for another 1,184 incidents.[10] Thus, as few as 42 percent and many as 81 percent of oil production-related incidents reported to the NRC may have impacted waters.[11] Exhibit 2 shows the number of incidents and total volume discharged for the period of 2000 through 2005. As shown in Exhibit 2, the number of incidents reported to the NRC from production facilities (represented by bars on the graph) remained relatively constant during the six-year period, with an average of 501 incidents per year. The annual volume of oil discharged (represented by the line on the graph) ranged from a low of 433,926 gallons in 2000 to a high of 735,769 gallons in 2003. These incidents reportedly released an average of approximately 548,000 gallons each year.

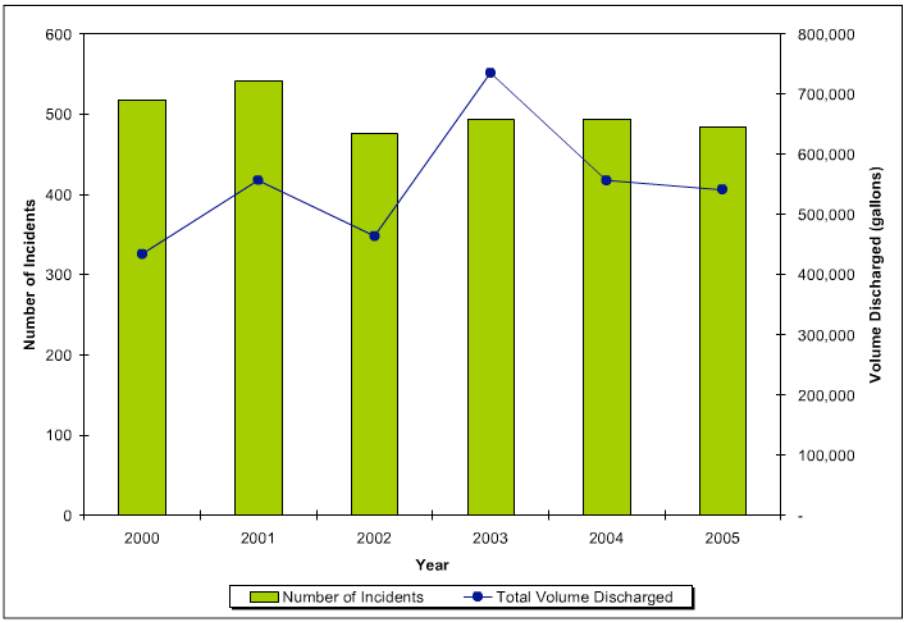

Exhibit 2. Number of reported incidents and volume discharge by year from onshore oil production facilities, 2000-2005 (NRC)

The average volume discharged per incident was 1,293 gallons, while a "typical" incident, as represented by the median volume discharged, involved 168 gallons of oil.[12]
Crude oil was the primary substance reported in over 96 percent of the spill incidents, and accounted for 73 percent of the total volume discharged during that period. Other incidents reportedly involved produced water contaminated with varying amounts of oil.[13]
Finally, approximately 5 percent of the discharge incidents (138 incidents) described inactive, orphaned or improperly abandoned production facilities (wellhead, flowline or abandoned tanks). In most instances, unquantified volumes of oil had been discharged over time rather than in one single incident. Such incidents are nevertheless counted as single incidents in the analysis, most often without an associated oil volume.

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[10] The data field containing the spill volume that reached water is left blank, and there is no indication in the incident description or other data fields that the spill has been contained and has not reached water.

[11] Assuming either the 1,260 incidents specifically identified by NRC as having affected water, or the 2,444 incidents for which the NRC does not specify that the discharge was contained to land or provide the amount in water as zero.

[12] A quarter of spill incidents involved 42 gallons or less, while another quarter involved 630 gallons or more.

[13] In many cases, discharges of produced water were specifically reported as crude oil discharge. For example, certain spills from produced water tanks were reported as crude oil discharges, presumably with the reported volume being that of the oil fraction. Other incidents which involved primarily treated produced water were described, for example, as "salt water containing oil"; "produced water (1% crude oil)", "oily water", "produced water with traces of oil", "produced water with skim of oil", and "salt water (1 barrel of oil mixed with the water)." For purpose of spill prevention and reporting requirements, these mixtures are considered oil.

Overall, the NRC recorded a total of 12,213 spill incidents for the period of 2000 through 2005 involving the types of oils associated with oil production activities (e.g., crude oil, produced water). NRC categorized approximately half of the incidents (6,281 incidents) as potentially involving SPCC-regulated facilities, based on the NRC-assigned incident type.[14] The analysis presented in the section above only considers the incidents that could be confidently attributed to onshore oil production facilities, based on the incident description (3,007 incidents). An additional 767 incidents had insufficient information to positively classify them as related to onshore production activities, while the remainder (2,507 incidents) more likely originated from other types of SPCC-regulated facilities (e.g., refineries, bulk storage terminals), offshore oil production facilities, or facilities that upon review are not subject to SPCC (e.g., transmission pipelines as opposed to flowlines or intra-facility gathering lines). At first glance, this suggests that onshore production activities represent a significant fraction (about half) of crude oil discharges reported to the NRC from potential SPCC facilities. The sheer number of spill incidents, the lack of detailed information provided in NRC records, and the limited time available to complete this analysis, however, prevented a more detailed evaluation of the source and circumstances of oil discharges not positively attributed to production facilities.

2.2.2. Geographical Distribution of Oil Discharges

As noted above, representatives of the E&P sector have raised concerns about SPCC requirements as they apply to facilities that produce from so called, "marginal wells", which are wells that produce 10 barrels of oil or less per day.[15] The NRC database does not provide detailed information on the operational characteristics of the facility from which a spill originates, and therefore it is not possible to ascertain which of the 3,007 incidents reported to the NRC and attributed to oil production activities occurred at facilities associated with marginally producing wells. A number of states produce oil predominantly from marginal wells. Exhibit 33 below summarizes the distribution of discharge incidents reported in the NRC database, by state. The exhibit identifies with the symbol "●" the states for which marginal wells account for 50 percent or more of the state's average oil production.[16] The last four columns in the exhibit provide the average oil production in the state during the period of 2000 through 2005, the state's share of domestic oil production, the estimated number of active oil wells, and the state's share of domestic oil producing wells.

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[14] Potential SPCC regulated facilities are here assumed to *exclude* platform, railroad, vessel, or mobile sources, as identified by NRC in the incident type field.

[15] Alternate definitions of marginal or stripper wells set the production thresholds to 15 barrels of oil per day or less.

[16] Estimates on the share of oil wells that are marginal were obtained from the Interstate Oil and Gas Compact Commission (IOGCC) (Source; Marginal Wells Fuel for Economic Growth, IOGCC, 2006. Report available at http://www.iogcc.state.ok.us/PDFS/2006-full-Marginal-Well-Report.pdf).

Exhibit 3. Distribution of oil discharge incidents (NRC) and oil production by state (in alphabetical order).

State	NRC Oil Discharges (2000-2005)		Annual Oil Production (2000-2005)		Crude Oil Producing Wells (2005) [1]	
	Number of Discharges	Share of Total	Average (Thousand Barrels)	Share of Total	Number of Wells	Share of Total
AK	64	2.1%	344,902	23.3%	2,766	0.6%
AL	131	4.4%	8,601	0.6%	814	0.2%
AR●	37	1.2%	7,065	0.5%	6,236	1.2%
AZ●	1	0.0%	55	0.0%	19	<0.1%
CA	311	10.3%	251,718	17.0%	44,007	8.8%
CO	27	0.9%	19,794	1.3%	6,862	1.4%
FL	–	–	3,572	0.2%	52	<0.1%
IL●	17	0.6%	11,206	0.8%	16,426	3.3%
IN●	4	0.1%	1,905	0.1%	5,375	1.1%
KS●	159	5.3%	33,792	2.3%	40,446	8.0%
KY●	78	2.6%	2,789	0.2%	18,000	3.6%
LA	852	28.3%	92,086	6.2%	21,962	4.4%
MI	3	0.1%	6,831	0.5%	4,200	0.8%
MO●	–	–	89	0.0%	320	0.1%
MS	114	3.8%	18,138	1.2%	1,531	0.3%
MT	14	0.5%	20,850	1.4%	3,888	0.8%
ND	11	0.4%	31,937	2.2%	3,120	0.6%
NE●	3	0.1%	2,722	0.2%	1,172	0.2%
NM	5	0.2%	65,544	4.4%	28,579	5.7%
NY*	4	0.1%	175	0.0%	3,270	0.7%
OH●	21	0.7%	5,952	0.4%	28,954	5.8%
OK●	250	8.3%	65,858	4.4%	82,533	16.4%
PA●	17	0.6%	2,377	0.2%	16,061	3.2%
SD	–	–	1,284	0.1%	181	<0.1%
TN●	8	0.3%	328	0.0%	450	0.1%
TX	467	15.5%	411,005	27.7%	149,300	29.7%
UT	21	0.7%	14,823	1.0%	2,328	0.5%
WV	121	4.0%	1,374	0.1%	3,213	0.6%
WY	267	8.9%	54,755	3.7%	10,389	2.1%
TOTAL	**3,007**	**100.0%**	**1,482,064**	**100.0%**	**502,460**	**100.0%**

NOTES:
(1) Source: Energy Information Administration, State Energy Profiles, accessed in January 2007. Profiles provide data on the number of crude oil producing wells in 2005.

2.3. Sources and Causes of Oil Discharges

EPA's analysis of NRC oil spills for the production sector reveals that sources of oil pollution included each of the various parts of an onshore oil production facility – i.e., wellhead, flowlines, tank battery, gathering lines, and water disposal system. According to the incident descriptions recorded by NRC, discharges from wellheads often result from leaking packing, valves and other appurtenances, or from wells that were improperly plugged and abandoned. Flowlines develop pinhole leaks, suffer corrosion damage, and are accidentally ruptured by impacts with vehicles or heavy equipment. Battery equipment, stock tanks, and process equipment spills include heater-treaters that develop leaks (often at the firebox), tanks being hit by lightning, tank overfills resulting from failure of various equipment

components, and leaking valves and other appurtenances. Gathering lines, like flowlines, tend to leak or rupture. Water disposal piping also frequently suffers corrosion damage and accidental impacts. Exhibit 4 summarizes causes and sources of oil spills.

Exhibit 4. Distribution of oil spill incidents from onshore oil production facilities according to spill source and cause, by number of reported incidents (NRC, 2000-2005).

	Spill Cause											
Spill Source	Accidental Impact	Cattle Interference	Corrosion	Equipment Failure	Leak, Hole, Rupture	Natural Phenomenon	Operator Error	Other Cause	Overfill	Unknown / Unspecified	Vandalism	Total
Appurtenances	--	1	2	37	3	4	7	3	--	10	6	73
Flowline	34	1	316	136	390	34	6	34	--	236	3	1,190
Gathering	38	--	209	33	90	5	4	28	--	144	--	551
Other Component		--	8	19	1	6	--	9	9	5	1	58
Separation equipment	1	--	12	68	14	5	2	5	4	13	3	127
Tank (Crude Oil)	--	--	2	12	9	5	3	--	18	7	1	57
Tank (Other/Unspecified)	--	2	8	34	22	14	8	6	50	22	6	172
Tank (Produced Water)	--	--	--	30	4	6	2	4	36	2	1	85
Tank Battery (Other/Unspecified)	--	1	9	33	10	14	3	11	8	23	4	116
Unknown/Unspecified	--	1	5	5	1	4	--	4	--	49	--	69
Water disposal	2	--	23	22	28	3	--	2	--	13	--	93
Wellhead	4	3	12	122	28	14	1	44	9	175	4	416
Total	**79**	**9**	**606**	**551**	**600**	**114**	**36**	**150**	**134**	**699**	**29**	**3,007**

The review of the NRC data suggests that, in terms of the number of reported incidents, flowlines, gathering lines, and piping associated with the waste disposal system are the most common sources of oil discharges, followed by wellheads (including improperly abandoned oil wells), and storage tanks.

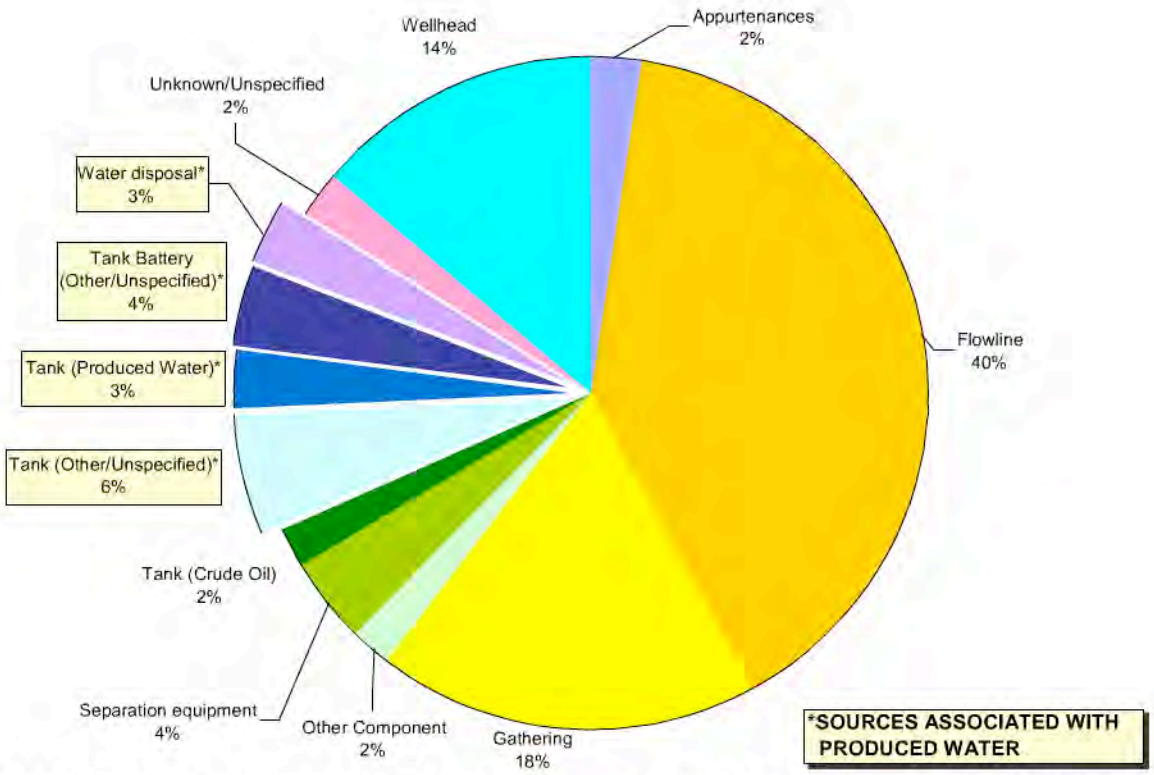

Exhibit **5**5 shows the relative distribution of discharge incidents by source, based on the NRC data for the period of 2000 through 2005. Components of the production facilities that are associated with produced water more specifically include Tank (Produced Water) and Water Disposal System. However, because the NRC records are not always specific in terms of the type of oil stored or transported in the equipment involved in a reported discharge, produced water may also be associated with other sources presented in Exhibit 10, including unspecified types of tanks or tank battery components. Certain gathering lines may also be transporting produced water.

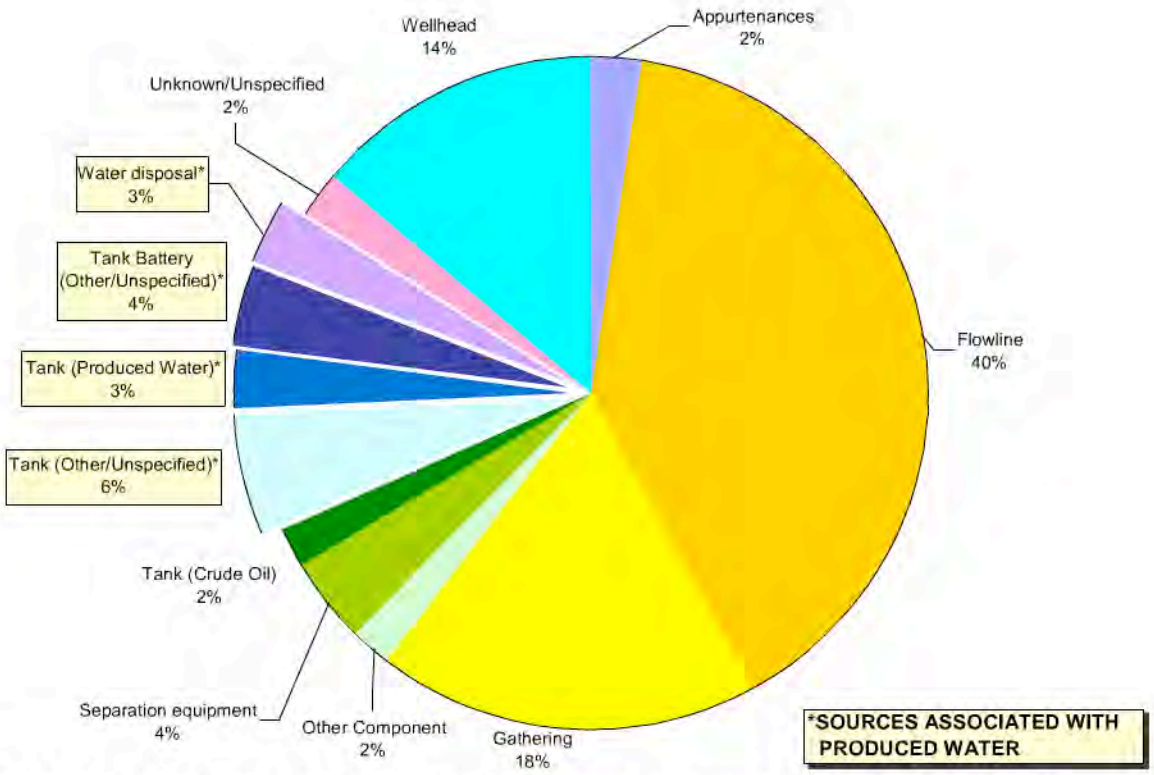

Exhibit 5. Distribution of discharge incidents from onshore oil production facilities, by source (NRC, 2000-2005).

Although flowlines are the most frequent sources of reported discharges, the volumes involved are generally smaller than from certain other sources, such as water disposal systems[17] and storage tanks. The NRC data show that, while an average of 440 gallons were discharged to water from flowlines per reported incident, the average volume ranged between 1,990 to 4,400 gallons for bulk storage tanks.

Exhibit 66 shows the relative distribution of the total volume discharged by source over the period of 2000 through 2005. Here also, a number of sources are associated with produced water, including tank (produced water), water disposal system, tank (other/unspecified), tank battery (other/unspecified).

[17] The water disposal system, as classified by EPA in the analysis of the NRC spill data, includes, for example, produced water lines, produced water disposal tank, produced water injection battery, and produced water header.

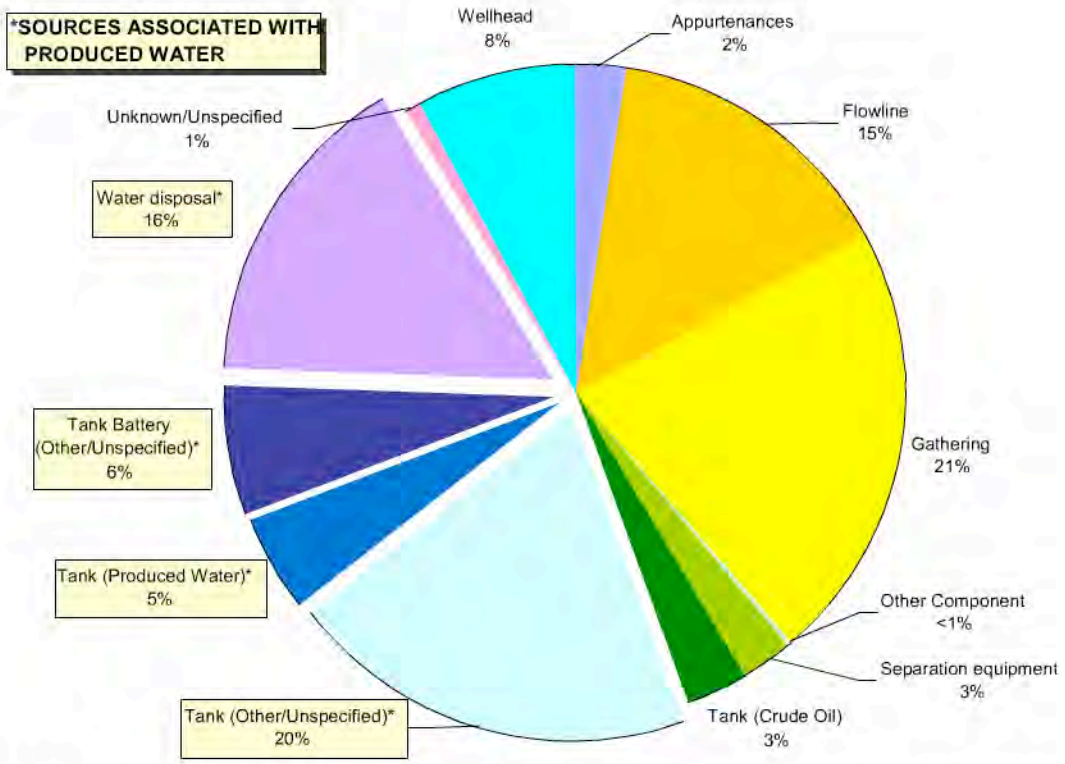

Exhibit 6. Distribution of the reported total volume discharged to water, as reported by NRC, from oil production facilities, by source (NRC).

The cause of an oil discharge tends to vary depending on the type of equipment from which the discharge originates. Exhibit 7 presents the distribution of production-related discharges reported to the NRC during the period of 2000 through 2005, by cause. As the exhibit shows, the most common specified causes of oil discharges from production facilities are small leaks, holes, and ruptures, either due to corrosion or unspecified reasons, and equipment failure. Operator error, overflows, natural phenomenon, and other causal factors are less frequently cited as the direct cause of a discharge, although they may be contributing factors in the spill circumstances. Exhibit8 presents the distribution of incidents by cause, based on the total volume discharged.

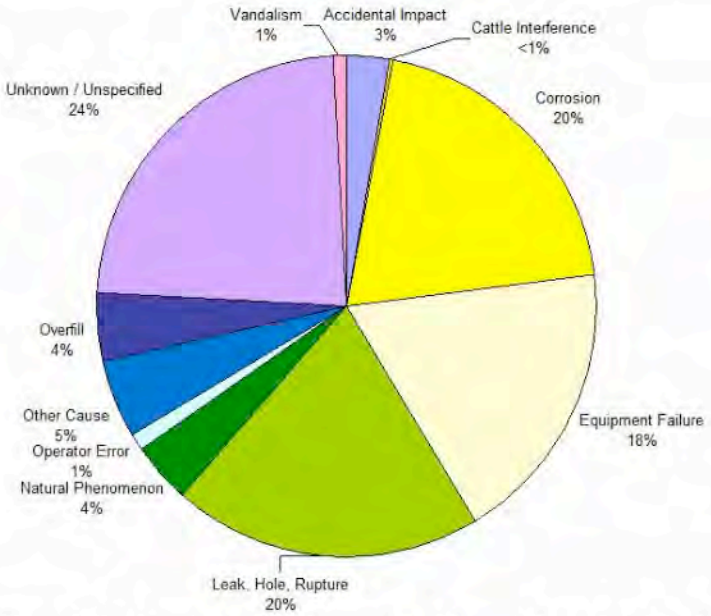

Exhibit 7. Distribution of discharge incidents reported from oil production facilities, by cause (NRC, 2000-2005).

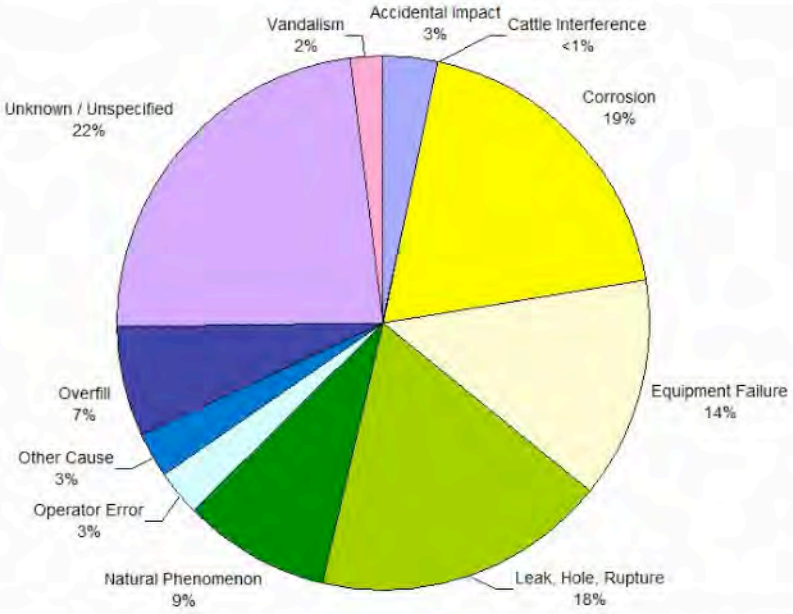

Exhibit 8. Distribution of the reported total volume discharged from oil production facilities, by cause (NRC, 2000-2005).

The spill data summarized above complement the anecdotal evidence provided by EPA field inspectors. For example, an inspector from EPA Region 3 notes that "most of the production-related spills in [EPA] Region 3 are caused by equipment failure (often weather-related or corrosion) and operator error."[18]

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[18] EPA Internal staff communication, Paula Curtin, EPA Region III, November 28, 2006.

When considering the volume of oil and oil mixtures released under different sources and circumstances, we note that, although they are the most commonly frequently cited causes of discharges, leaking, punctured, and ruptured production equipment generally result in smaller volumes being released than when other spill causes are involved. Thus, for discharges originating from tanks or tank batteries, natural phenomena (e.g., flood, hurricane) and vandalism led to larger average oil volume discharged (16,000 and 6,700 gallons, respectively) than other causal factors such as leaks (2,500 gallons), overflows (2,300 gallons), or corrosion damage (2,000 gallons). For flowlines, the largest average discharges were caused by human error (1,900 gallons) and accidental impacts (530 gallons) such as in cases where a vehicle or piece of heavy equipment hits a flowline or gathering line. At the wellhead, cattle interference and vandalism were significant contributing factors to the larger discharges.

3. Limitations

The discussion above relies on the available data on oil spills reported to government authorities from production facilities. As such, it is subject to the limitations of these data sources in terms of comprehensiveness, accuracy, and completeness of the information.

3.1. Comprehensiveness

One limitation of the analysis relates to under-reporting of spill incidents. The data source we used only captures discharges reported to the authorities. Additional incidents may have gone unreported, as discussed later in this section. Consequently, oil discharge statistics discussed in this section likely under-represent the actual frequency of discharges. Problems with under-reporting of spills to the NRC have been documented in the past by other authors.

3.2. Accuracy of Reported Oil Volumes

Volumes reported are generally those estimated by the individual reporting the incident and may differ from actual quantities discharged. Additionally, not all discharges have reported volumes. Since EPA did not attempt to estimate oil volumes for the 459 incidents for which the information was missing from the NRC records, total volumes presented for the NRC and state databases represent only a portion of spill incidents. Therefore, the actual volume discharged could be higher than that presented in the analysis. Conversely, EPA did not convert produced water volumes into corresponding crude oil volumes. EPA does not set threshold oil concentrations above which a discharge of an oily mixture may be harmful, as per 40 CFR part 110. Produced waters often contain free oil and are reportable if they create a sheen or violate a water quality standard.

3.3. Selection of Production-related Spill Incidents

Furthermore, EPA selected relevant spill incidents conservatively, only considering incidents that could be positively identified, based on the information provided in the records, as likely originating from an onshore production facility. This may have left incidents that may be associated with production facilities but could not be reliably associated with production activities based on information in the NRC incident report. An additional 485 incidents in the NRC database were suspected to be production-related given the location, type of oil and equipment involved, but had insufficient information to conclusively classify them as relevant discharges for the purpose of this analysis. These incidents include a large number of spills

from piping or tanks where there was insufficient information to determine whether the piping or tank was production-related.

Finally, the analyses presented in this section only consider incidents from production facilities that involved crude oil and/or produced water/saltwater oil mixtures. Although those oils are expected to represent the majority of oil discharges from production facilities, there may be other types of oils present at those facilities that could also be discharged.

4. Conclusions

Onshore production facilities are responsible for a large number of oil discharges to U.S. waters. During the period of 2000 through 2006, there were over 3,000 oil spills reported to the National Response Center (NRC) originating from onshore oil production facilities, based on discharges that could positively be attributed to production-related activities and equipment according to the information provided by the NRC. At least 40 percent, and as many as 80 percent of these incidents reportedly affected waters, according to the NRC. Increased outreach on spill reporting requirements could lead to more accurate NRC data in the future.

Among the discharge incidents reported to the NRC related to production sector facilities, the data show that flowlines and piping associated with the gathering system are the most frequent sources of reported oil discharges. Other important sources of discharge include the produced water disposal system and other facility components associated with produced water storage. In terms of the volume of oil discharged, crude oil storage tanks and produced water disposal system components (both tanks and piping) account for nearly half of the total reported spill volume. Corrosion continues to be a contributing factor in a large number of discharge incidents. Equipment failures and overfills also occur with significant frequencies. Information about the causes and circumstances of reported oil discharges suggests that some of these discharges are preventable altogether, or could be mitigated, by implementing spill prevention measures such as engineered containment structures, regular inspections of production equipment, and preventive maintenance. A review of spill data reveals numerous cases where impacts to water were prevented by secondary containment berms that contained the oil release within the production facility.

Appendix A: References

40 CFR part 110. Discharge of Oil

40 CFR part 112. Oil Pollution Prevention and Response

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Appendix B: Analysis of Spill History

B-1 Methodology Used to Analyze National Response Center Oil Spill Data

EPA reviewed information contained in the National Response Center (NRC) database to identify reported discharges that could be attributed to onshore oil production facilities. The NRC data are available for download on NRC's website.[19] At the time of our analysis, data were available for calendar years 1982 through 2005.

The review focused on discharges of production-related fluids (e.g., well fluids, crude oil, produced water) for which the incident description suggested a reasonable likelihood that the incident was production-related. Additionally, we also eliminated from our selection discharges reportedly located in coastal or offshore environments (e.g., at production sites in the Gulf of Mexico). The following text summarizes the methodology:

- Step 1: Identify potential spills based on material released. We identified the spills that could potentially have originated from production facilities by flagging materials in the NRC database that could be production-related. Oil materials that we could reasonably assume would not be directly related to production activities, such as refined products or non-petroleum oils, were eliminated from the selection criterion. We did retain, however, gas condensate and mixtures of oil and water which could not a priori be eliminated from the shortlist. This initial selection yielded a list of over 6,300 associated discharges.
- Step 2: Eliminate discharges not likely to be associated with production activities. We applied various selection criteria to eliminate from the initial list discharges that would not be expected to be production-related given the location, responsible party, type of equipment, or other information recorded by NRC. Criteria used to eliminate these discharges included incident, location or responsible party descriptions that included variants of terms such as "terminal", "station", "offshore", "refining", "platform". They also included discharges identified by NRC as originating from "transmission" or "distribution" pipelines or where the pipeline is specifically identified as DOT-regulated, or described as having a diameter larger than 36 inches. We also eliminated incidents related to drilling and workover activities ("drilling"). While this process of elimination was helped by applying selection criteria to identify subsets of incidents to review, each incident was ultimately manually reviewed to ensure that it was safe to assume that the incident could be eliminated.
- Step 3. Review individual incidents. We further reviewed incidents that could not be eliminated through Step 2 by sorting through the ancillary information for any further indication that the incident could be either positively identified as production-related (e.g., use of terms such as battery, production, gun barrel), or negatively identified as not likely to be production-related. Criteria applied to negatively flag incidents included cases where 1) the responsible party is a company with only downstream activities according to information available on the company's corporate website

[19] http://www.nrc.uscg.mil/download.html

(e.g., Hovensa, Valvoline, Pennzoil), 2) the reported location is a known refinery or chemical manufacturing plant of an integrated oil company, or 3) the responsible party only provides transportation services of refined products (e.g., Terasen, Kinder-Morgan). This step also included reviewing offshore oilfields listed by the Minerals Management Service as located in the Gulf of Mexico or identified on topographical maps (Black Bay, LA, Galveston Bay, LA) to eliminate incidents that did not occur within the inland zone.

- Step 4: Score records based on likelihood that discharge is production-related. This step involved reviewing over 6,000 remaining incidents individually to assign a numeric confidence score that the incident originated from a production facility. Scores below "8" were used to identify incidents that have a reasonable probability of being associated with a production facility. The various scores indicate confidence that an incident is production related (e.g., certain, likely, probable) or the type of facility (e.g., abandoned facility, saltwater/injection facility, gathering network). A score "8" was used to identify possible production-related incidents for which more information would be needed to positively state that they are production-related; score "9" identifies non-production incidents, while "10" identifies incidents for which information is insufficient to make a determination (e.g., unknown sheen reports). Finally, "11" identifies offshore production-related incidents.
- Step 5. Categorize incidents by source and cause. This step involved classifying production-related incidents according to the source and cause of the discharge. We manually reviewed all records with scores lower than 8 (3,023 discharges) to assign a source and cause to the two corresponding data fields. Where multiple sources and/or causes were described, we assigned the source/cause that appeared most directly related to the release of oil. For example, in a case where the valve on an oil/water separator fails and results in a tank overfilling and releasing oil, the source of the spill is assigned as a tank, and the cause is assigned as an overfill. In the case where cold temperature causes a coupling to split on a flowline, the source of the spill is assigned as the flowline, and the cause is assigned as equipment failure.
- Step 6. Eliminate duplicate records and group into unique incidents. This final step involved deleting duplicate records by reviewing multiple incidents reported on the same date and states, and identifying unique discharge incidents from the resulting 3,023 discharge records. This was done by identifying unique values in the SEQNOS field the NRC uses to identify each notification call, and by summing volumes reported across different oil substances released in the same incident. This step identified 16 incidents involving the release of more than one oil substance. Since the data selection retained only oil data records, both the interim and final dataset only consider the reported volumes of oil.