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Secondary Containment:
Regulations and Best Management Practices in the Appalachian Basin

Beth Powell, New Pig Energy Corporation

Abstract

Secondary containment for oils used during drilling and completions may be required by federal and state regulations. At the state level, Pennsylvania has the one of strictest and most comprehensive secondary containment regulations. It not only regulates oils; it also regulates flowback water and requires Master Containment Plans.

Since drilling rigs and completion crews are mobile and utilize large volumes of oils and flowback water, passive temporary secondary containment is the preferred method. Best management practices for site preparation, installation, testing and maintenance are discussed.

Introduction

Surface spills of oils, fracturing fluids and flowback water are a risk to groundwater and surface waters. Sources of spills at the pad include the drilling rig, mud tanks, diesel tanks, frac tanks, sand kings, generator sets, light stands, contractor vehicles and blowouts at the wellhead.

Secondary containment is a safeguarding method in addition to the primary containment system (e.g. tanks, pipes, drums, blowout preventer). The goal of secondary containment is to prevent a spill from reaching surface waters or groundwater through the use of liners or other barriers. Common secondary containment options include dikes, berms or retaining walls sufficiently impervious to contain oil; curbing; culverting, gutters or other drainage systems; weirs; booms; barriers; spill diversion and retention ponds; sorbent materials; drip pans; and sumps and collection systems. (40 CFR 112.7 (c)). There are two types of secondary containment, according to the federal definition: specific and general.

Specific Secondary Containment

Specific secondary containment requirements are intended to address a major container failure (the entire contents) associated with a bulk storage container; single compartment of a tank car or tank truck; mobile/portable containers; and production tank batteries, treatment, and separation installations. Provisions explicitly provide requirements for sizing, design, and freeboard.

General Secondary Containment

General secondary containment requirements are intended to address the most likely discharge (typical failure mode and the most likely quantity) from bulk storage containers; mobile/portable containers; production tank battery, treatment, and separation installations; a particular piece of oil-filled operational or process equipment; non-rack transfer activity; or piping in accordance with good engineering practice. At the federal level, the Onshore Oil Drilling and Workover Provision (40 CFR 112.10(c)) only requires general secondary containment, a blowout prevention (BOP) and catchment basins or diversion structures to intercept and contain discharges of fuel, crude oil, or oily drilling fluids. Specific containment is not required.

General secondary containment can be passive (does not require human intervention to function) or active (does require human intervention). Due to the large volumes in the diesel tanks and frac tanks involved in drilling and completions, secondary containment tends to be passive, such as liner and/or berm systems. Active measures such as vac trucks, spill trailer and absorbents are unlikely to be deployed in time to prevent a large spill from leaving the pad.

Federal Regulations

The major federal regulation regarding oil storage at well sites is the Spill Prevention, Control and Countermeasure (SPCC) Rule.

Spill Prevention, Control, and Countermeasure Rule

This rule is part of the Clean Water Act's Oil Pollution Prevention Regulations (40 CFR 112). The purpose of SPCC is to develop plans designed to prevent oil discharges from reaching the navigable waters. It was first codified on December 11, 1973, and took effect on January 10, 1974.

SPPC plans should include containment and procedures to *prevent* oil discharges; proactive *control* measures to keep an oil discharge from entering navigable waters (containment); and effective *countermeasures* to contain, clean up, and mitigate any oil discharge that affects navigable waters (spill response measures). (SPCC 101)

Amendments in 2002, 2006 and 2008 provided container size clarification for storage capacity; exemptions for operational equipment and tank trucks; tiering and templates for smaller facilities; a revised definition of "facility"; and clarification on general secondary containment requirements.

Definition of Oil

SPCC only regulates oil. But, it is oil of any kind or in any form, including (but not limited to): fats, oils, or greases of animal, fish, or marine mammal origin; vegetable oils, including oils from seeds, nuts, fruits, or kernels; and other oils and greases, including petroleum, fuel oil, sludge synthetic oils, mineral oils, oil refuse, or oil mixed with waste other than dredged spoil. (40 CFR 112.2).

Oil SPCC rules are not limited to petroleum-based oil products. They also include natural gas drip or condensate, synthetic, hydraulic, lubricating, and mineral oils. A good rule of thumb is if a substance coats or floats, it is probably an oil. Not included within the SPCC definition of "oil" is natural gas and highly volatile liquids that volatize on contact with air or water (e.g. liquid natural gas, liquefied petroleum gas). (SPCC Guidance)

The EPA Office of Emergency Management is working on policy for flowback water since it contains both the initial slick additives, as well as, contaminants from the reservoir. If the flowback water contains recoverable amounts of oil, spill prevention measures should be implemented because and oil/water mixture is an oil by the EPA definition.

SPPC Applicability

For the SPCC rule to apply to drilling operations, two criteria have to be met. First, the oil storage capacity on site must be greater than 1,320 gallons (from containers of 55 gallons or more) or underground capacity greater than 42,000 gallons. The diesel tanks on the drilling rig and the gen sets during fracturing typically met the above ground threshold. Second, an oil discharge could "reasonably be expected to discharge oil into navigable waters of the US or adjoining shorelines" (40 CFR 112). Navigable waters include surface waterways, such as streams, creeks, rivers, and lakes; wetlands adjacent to a navigable waterway; and intermittent streams.

The EPA declines to enumerate a specific distance to navigable waters from which a facility must be located for purposes of determining SPCC applicability. (67 Fed. Reg. at 47060). A determination should be based on geographical and location aspects, such as proximity to water, land contour, and drainage. Manmade features, such as dikes around tanks, have to be excluded in determination. (§112.1(d)(1)(i))

Appalachian Regulations

Due to SPCC and API recommend practices (51R) and guidance documents (HF3), secondary containment for drilling mud, diesel tanks and fracturing additives is common practice in most plays, unless drilling in an arid location that is unlikely to discharge to navigable waters. The use of liners under the drilling and completion operations, however, started out as industry's response to limit the number of Notice of Violations (NOVs) for surface spills to ground. It is important to point out that federal regulations trigger a violation when navigable waters are impacted (surface sheen), but Pennsylvania's trigger is a spill to ground, not to water. The reportable quantity is five gallons. This best management practice to contain the site became regulation in Pennsylvania on April 16, 2012. It not only encompasses the oils used on site; it brings flowback water under secondary containment regulation. This state now has the strictest secondary containment regulations for the Marcellus and Utica plays. Ohio and New York are considering similar regulations.

Pennsylvania Act 13 of 2012

Unconventional well sites must be designed and constructed to prevent spills to the ground surface or off the well site. Containment practices must be in place during both drilling and hydraulic fracturing operations and must be sufficiently impervious and able to contain spilled materials, and be compatible with the waste material or waste stored within the containment. Containment plans must be submitted to the department and describe any equipment that is to be kept onsite to prevent a spill from leaving the well pad.

Containment systems shall be used wherever drilling mud, hydraulic oil, diesel fuel, drilling mud additives, hydraulic fracturing additives, and/or hydraulic fracturing flowback are stored. Containment areas must be sufficient to hold the volume of the largest container stored in the area plus ten percent. (§3218.2 of the Act).

Master Containment Plans

The containment plans mentioned in the act are called Master Containment Plans (MCP) and were required for unconventional well permits starting October 14, 2012. The detailed plans should include the installation, utilization, integration and maintenance plan of all potentially used containment systems, as well as manufacturer's specifications on materials used, installation directions, maintenance requirements, chemical compatibility, warranted uses and reuse/disposal considerations. The MCP should state how the secondary containment system will be used in practice, either as local containment or as complete containment. (Act 13 FAQs)

Local Containment

Local containment is only deployed at the site of the reservoir (tanks), such as diesel fuel tanks, chemical tanks, roll offs, drilling rigs and trucking transfer stations. These systems may also include using a spill deck under all chemical storage tanks of a certain size or deploying a collapsible portable containment system around all diesel fuel tanks. If localized subsurface liners are used, departmental staff can require that sections of the liner be removed for inspection and sampling if a spill occurred. This is to ensure that the liner prevented a release onto the ground. (Act 13 FAQs)

Complete Containment

Complete containment is deployed for the entire well pad operation. When employing this type of practice:

1) State whether or not the liner system is a surface or

subsurface liner system. If it is a subsurface liner, the plan must specify what type of stone will be used.

2) Choose a liner that is
   a. Durable--Able to support the weight of heavy equipment, such as drilling rigs and trucks.
   b. Impervious--Constructed from a synthetic material with a coefficient of permeability of no greater than 1 x 10^{-10} cm/sec and with sufficient strength and thickness to maintain the integrity of the liner.
   c. Chemically Compatible--Designed, constructed and maintained so that the physical and chemical characteristics of the liner are not adversely affected by the waste and the liner is resistant to physical, chemical and other failure during transportation, handling, installation and use.

3) Identify the type and thickness of the liner and the installation procedures to be used.

4) Verify that adjoining sections of liners are sealed together to prevent leakage in accordance with the manufacturer's directions.

5) Design the liner system and site grade to efficiently collect and remove spilled material, waste and rainwater.

6) Ensure the berming of the entire pad meets the permeability standard. (Act 13 FAQs)

Inspection and Maintenance Plan

The Master Containment Plan must include an inspection and maintenance plan for ensuring the timely and quality repair of damage that is caused to any containment systems including, but not limited to: tears, punctures or any condition that compromises the maximum permeability requirements of the liner system. (Act 13 FAQs)

Liner Containment Systems

In support of the Act 13 and the Master Containment Plans, three types of containment are typically found on Pennsylvania well pads: pad, tank and equipment.

Pad Containment

This is the main liner that is placed over a large square footage, typically centered off the wellheads. The liner installed before rigging up and before a completion move. Berming is typically 6" to 8" high. Although some operators tie into plastic barricades (to control traffic to designated areas), the entrance ways are typically only 6" to 8". The liner may be directly attached to the cellar walls, either mechanically or with a coating, to prevent any back up at the well head from pushing under the liner.

Tank Farm Containment

This is the containment under the battery of frac tanks and may or may not be on top of Pad Containment. Plastic, metal or concrete barricades are used to provide high walls to meet the 110% containment of the largest tank. If walls are 2' or higher, bridge ladder may be used to enter/exit.

Equipment Containment

This liner is placed directly under equipment that is leak prone. It may be on the Pad Containment to limit spread (mud tanks, pump house) or it could be under a generator, light post, sewer treater, etc. that is off the Pad Containment. Berming is typically 6" to 8" high.

Best Management Practices

The following sections contain lessons learned in the Appalachian Basin. They have been field tested by numerous operators.

Sub-base

1) The sub-base needs to provide a flat, firm foundation.

2) If the top layer of the sub-base is too hard, such as soil cement, protruding debris and stones cannot be pushed down by traffic and can result in punctures.

3) If the top layer of the sub-base is too soft, such as mud or high-clay content soil, developing ruts will cause traffic to bounce and embed forks in to the liner. The rutted areas also do not support the liner, which can result in tears.

4) The sub-base has a large effect on the number of patches required throughout the liner lifetime. A gravel base will shift to disperse load; 3/4 inch to fines limestone (2A modified, crusher run, #57) is recommended. Rounded stones may result in few punctures--but may develop ruts.

5) All pads should be rolled before the liner is installed.

Seams

1) Large panels should be seamed together with a wedge welder, not a hot air gun or extrusion welder, to ensure good seam contact over long lengths.

2) The hot air gun and extrusion welder should only be used for spot repairs or detail work around obstacles.

3) The welder should be set to the correct temperature and speed depending on liner and site conditions.

4) Suspect field seams should be tested for water tightness. A vacuum plate test is non-destructive.

Berms

1) If secondary containment walls are higher than 2', use a bridge ladder to enter and exit the area.

2) To maintain designated entrance areas, string flag or place plastic barricades around the perimeter. Avoid posts that could be impalement hazards.

3) Do not use metal L-brackets to build spot containment. They are an impalement hazard.

4) If corrugated pipe is used to make the berm, the sections that meet to establish a corner should strapped together to prevent kick out.

Maintenance

1) Inspect the containment on a frequent basis for holes and berm issues.

2) Patch according to manufacturer’s instructions. Mud and water must be removed before applying the patch.

2) Vacuum off standing water before it freezes. If over an inch, it takes a long time to melt off.

3) Use dark colored liner in the winter. The sunlight in the morning will quickly melt ice and evaporate water.

4) A rotatory nylon brush is highly effective at removing construction dirt, sand and snow from the surface of the liner. A street sweeper, that applies and picks up water, is more effective at removing trace amounts of dirt and sand.
5) Do not place pipe racks directly on the containment liner. Use rig mats/isolation pads or keep the liner tight to the catwalk.
6) For closed-loop systems, use rig mats in the back yard for the drill cutting bins and track hoe path.
7) Use outrigger pads when positioning heavy equipment on the containment liner.
8) If the liner installation will be used for both drilling and completions, tack drop cloths around the well heads. When drilling is complete, these areas are typically contaminated and can be easily removed before the completion operations begin.

Safety

1) Use liners with high coefficients of friction (COF) to limit slips and falls. Avoid ones with smooth surfaces. Also avoid textured ones with smooth seams since there is a large change in the COF between the two areas. A consistent, high COF is critical when snow, ice and drilling mud are present on the surface.
2) Active winter snow removal greatly reduces ice buildup.
3) Limit loose layers and wrinkles in the containment liner. Wrinkles should be pulled out during installation and after equipment is placed. The edges should be weighted down until berming is complete.
4) Do not place grounding rods in high traffic areas. They are an impalement hazard. Cover exposed rod ends with buckets, tennis balls or other protective cushioning.

Spill Prevention

1) Liners should be designed for the application. Liners exposed to vehicles and equipment should be highly resistant to tears and punctures.
2) If grounding rods are placed through the liner, boots and standing pipe must be used to maintain sump capacity. The height must be at least as tall as the berm.
3) To avoid spills backing up ender the liner, place a liner sleeve into the cellar and bond the liner edges to it to conform to the opening. This should then be either mechanically fastened or sprayed to the cellar walls.
4) Clean up hydrocarbon spills as quickly as possible, such as drilling mud and pipe dope. Place catch basins where this is likely to happen (e.g. valves).
5) Liner should terminate at or beyond the top of the berm. The lowest point of the liner determines the entire containment's sump capacity.
6) Avoid parking on the berm since this lowers the overall sump capacity.
7) When forming corners, ensure edges of the liner remain at the top of berm.
8) Fuel tanks should be double-walled. Some operators place them on two liners (Pad and Equipment/Tank Containment), with the second cut to fit around them specifically. This provides four levels of containment.
9) Repair tears quickly to reduce tripping hazards.
10) Barricades or flags at the corners reduce damage caused by contactor vehicles.
11) Fluid transfer is a high risk activity for spills. If the transfer is not occurring with a liner present, place catchment basins under the connections and valves.

Conclusions

Secondary containment on drilling and completion sites requires planning and inspection to ensure compliance with federal and state regulations. The sub-base, inherent liner durability, and seaming method have a direct impact on the long-term functionality of the containment system. Maintenance programs should address inspection frequency, correct patching methods and berm repair. Control of traffic and contractor training on the site will greatly reduce maintenance costs. When choosing the liner or other barrier, be aware of safety concerns. In cold and wet climates, a high coefficient of friction surface can significantly reduce slip and falls. Limiting wrinkles, removing spills and repairing tears also have a direct impact on safety.

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