Development of a Secondary Containment System for Flammable and Combustible Liquids

Introduction and Background

The current Alberta Fire Code requires a CAN/ULC S668-12 compliant liner for the secondary containment of flammable and combustible liquids. The Code further requires that the liner be non-combustible or covered with a non-combustible material, to provide containment in the event of a spill which catches fire. Another requirement is to maintain a hydraulic conductivity of less that $1x10^{-7}$ cm/second.

All ULC compliant secondary containment liners are currently organic (combustible) materials and they must be protected by a non-combustible layer.

This is easily accomplished for the horizontal portions of the containment; the liner is covered with soil/sand and this provides adequate protection. On vertical or steep berm walls however, this solution is not feasible.

Current industry practice is to cover the base and berm walls with the same liner, covering the base with fill while leaving the vertical berm area exposed. This does not meet the current Alberta Fire Code.

Objective

This project was undertaken to develop a ULC compliant lining system for vertical or steep berm walls which will remain intact and maintain containment in the event of a spill/fire.

System Development

To accommodate both the permeability and combustibility requirements, a composite lining system is required. A ULC compliant polyurea spray applied liner was selected to be the base containment liner. This product was Precidium™ ECS™ FR (ECS FR). This product offers the advantage of being fire retardant (it will burn in the presence of flame, but self-extinguishes when the flame source is removed), and has a hydraulic conductivity value which exceeds the ULC requirements. ECS FR also has a very high melting temperature (250 °C) for a polymer as compared to polyethylenes which melt at 135 °C or lower.

The main requirement of the project was to adequately protect the ECS FR from high temperatures and exposure to flammable liquids in the event of a pool fire to maintain containment.

Testing Procedure

Testing was designed to replicate a worst case scenario. This involved a pool fire in the secondary containment followed by a larger spill filling the containment to the top with hydrocarbon. This testing also replicated a pool fire which was rising in the containment as the spill continued.

Potential lining systems were constructed in a 3' x 3' metal frame (bottomless so any leaks could be detected) with 10" high vertical walls lined with ECS FR and numerous forms of insulation. The systems were constructed with a base layer consisting of 4" of sand. Each system was then filled with 25 litres of methanol and ignited. A 20-30 minute fire with temperatures exceeding 800°C was applied to each system, with the fires self-extinguishing as the methanol was consumed. Following the fires, the systems were hydraulically tested by filling to the top with water to check for any leaks. The systems were then disassembled and the ECS FR liner was inspected for any damage.

Observations and Data

As a base line, an exposed HDPE liner system, and an HDPE covered with cement board system was fire tested. In both cases the liner was completely consumed/melted and the system failed.

A system comprised of ECS FR covered with Precidium™ ECS™ HS (ECS Heat-Seal) (heat resistant elastomer) was then trialed. Heat resistant elastomer liners are sacrificial layers, such that they burn when exposed to flame, and the char swells to many times the thickness of the original liner providing insulation to the underlying layers. ECS FR covered with ECS Heat-Seal did not provide adequate insulation and the system failed.

Additional components to cover the ECS FR which were tested included fiberglass fabric coated with ECS Heat-Seal, cementitious and mineral fiber fire protection products for structural steel, and leaving an air gap between the ECS FR and a fiberglass cloth/ECS Heat-Seal layer. All of these systems failed with the exception of the cement based protection for steel which proved to be far too costly.

Thermal ceramic blankets were draped over the vertical portion of testing frames and proved to provide adequate insulation, but were very absorbent of hydrocarbon liquid and water. This posed a problem for in-service performance as exposure to a hydrocarbon fluid or natural weathering would make the blankets unworkable. Ceramic blankets encapsulated with foil were sourced to combat this problem.

An additional challenge was how to secure the blankets on the berm wall, as the blankets are quite heavy over typical berm wall heights. A batten bar was used to spread out the anchoring over the entire width of the blanket. Battening also solved a recurring problem of fire accessing the ECS FR liner at the top of the berm, and causing failures in the upper portion of the containment.

Conclusion and Summary

The composite lining system successfully pass the test design criteria was comprised of the following components : 60 mil ECS FR sprayed on the berm wall, a layer of thermal ceramic blanket encapsulated with foil, and finally a high temperature fiberglass fabric top coated/sealed with 60 mils ECS Heat-Seal.

The condition of the ULC compliant containment liner following a fire test is shown below. It remained intact and reusable.

Figure 1.0 – Secondary Containment Liner Precidium™ ECS™ FR Post-Burn

ECS Heat-Seal is a low flame spread, low smoke development sacrificial liner in the event of a fire, and also an excellent containment liner for hydrocarbons in the event of a spill which did not catch fire.

This composite lining system passed the fire test, and upon inspection, had only minor scorch marks, leaving the ECS FR liner intact and reusable after a fire.

In conclusion, a CAN/ULC S668-12 compliant secondary containment liner on vertical berm walls was adequately protected from high temperatures and flammable liquid to provide containment during and after a pool fire. This was accomplished by implementing a composite lining system comprised of ECS FR, dual insulation layer, and ECS Heat-Seal.