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Secondary Containment Design for the LLNL B801 Diala Oil Tank

E. Mertesdorf

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Secondary Containment Design
For the Lawrence Livermore Laboratory
Building 801 Diala Oil Tank. Piping
Secondary containment

Purpose:

Design is to add an extension to the secondary containment of tank T1-A3 at building 801. Piping from the inner tank penetrates the secondary containment tank below the liquid level of the primary tank. To meet Oil Pollution Prevention Regulation 40 CFR 120.7 the single wall piping needs to be provided with secondary containment. Steel Tank Institute (STI) conference publication states: §112.3(d)(1)(iii) –SPCC Plan requirements- Systems shall be designed in accordance with good engineering practice, including consideration of applicable industry standards and that procedures for required inspections and testing have been established. Section 112.7(a)(2) allows for deviations from specific rule requirements, provided the Owner/operator responsible to select, document and implement alternate measure and a PE certifies the SPCC Plan in accordance with good engineering practices, including consideration of industry standards

Discussion:

The secondary containment must ensure a leak from the piping or valves below the liquid level are contained. In the case of tank T1-A3, a leak in the piping or valves coming out of the tank primary containment, until it reaches a height above the liquid level of the tank could result in the uncontrolled release of the tank contents. The proposed addition is consistent with the requirements of the Office of Solid Waste and Emergency Response (OSWER 9360.8-38) issued August 9th, 2002, and provides secondary piping containment meeting good engineering practices. The added containment design is fore the piping and does not communicate with the existing secondary containment.

Assumptions:

Proposed design approach:

This design approach involves revising the tank piping to not use any primary tank piping that is below the top of the tank. New replacement piping will enter the primary containment from the top.

The three existing primary tank pipes below the top of the tank will be fitted with new piping plugs to effectively move the primary containment boundary to within the existing primary containment. Screw on or bolt on, caps or flanges will be installed using existing the pipe threads or flange, with view ports to create a secondary containment area that can be easily inspected.

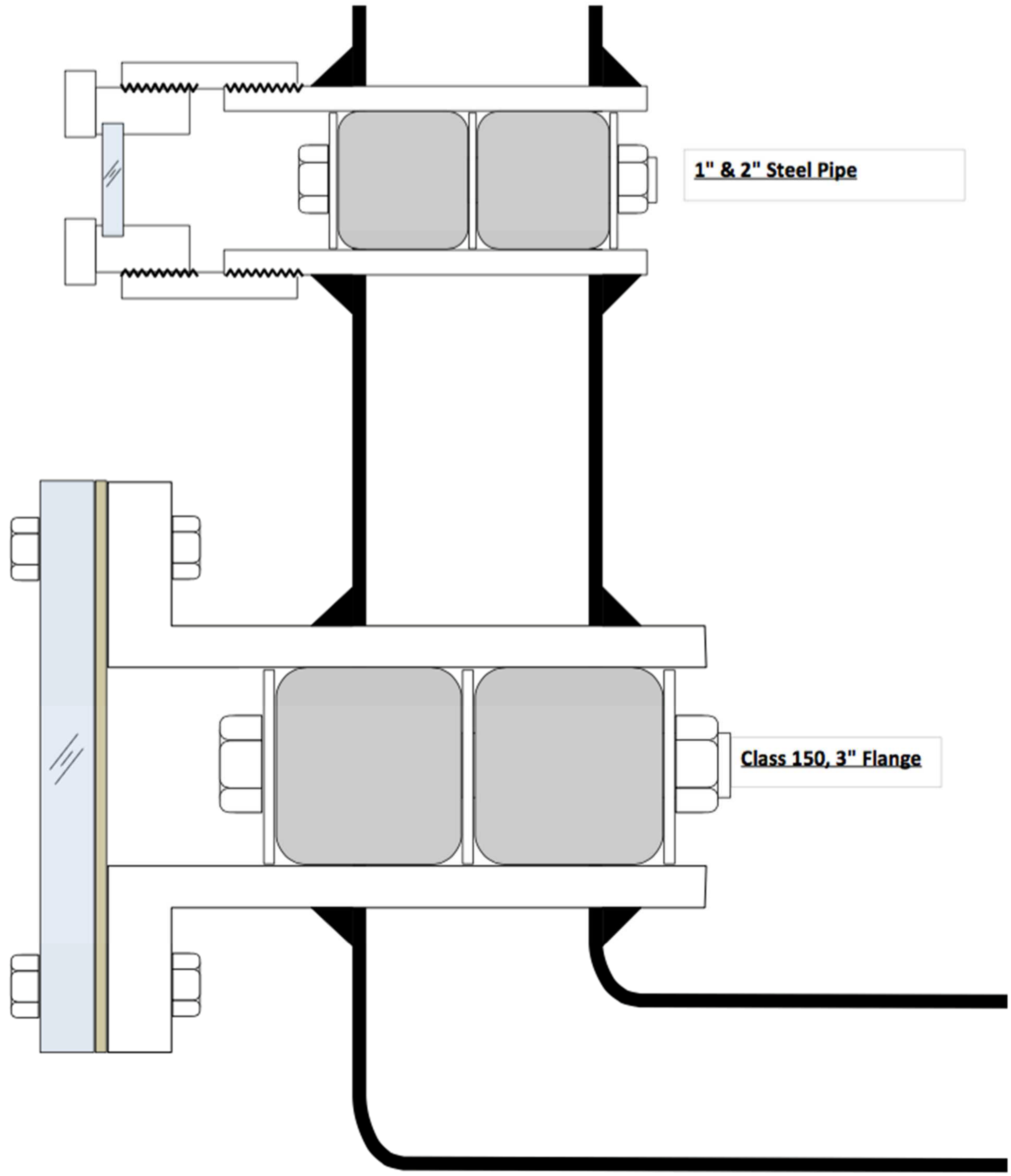

Figure 1 Pipe plug general design

This approach does not change or modify the existing UL listed tank. This has been corroborated by the tanks original manufacturer. Therefore, Steel Tank Institute and UL-142 standards for modification of tanks are not invoked.

The Plugs will be procured from an ISO9000 qualified company whose business is the design and manufacture of custom pipe plugs.   Steel parts are to be Aluminum and the plug seal is to be made of Nitrile. Nitrile has been confirmed to be compatible with Diala Oil. The design pressure for the plug will be specified as 50 PSI which is well over ten time the worst case scenario. The plugs will be similar to the picture below.

Secondary containment Calculations:

There are two types of designs for the secondary containment, one involves using the existing the threads on the existing tank piping and one involves connecting to the excising tank pipe flange.
The existing tank piping is schedule 40 steel pipe.

Threaded pipe secondary containment:
The threaded secondary containment consist of standard class 150 ASTM A865, or ASTM B16.11 threaded pipe fittings with the addition of an off-the-shelf view port. All components are rated for a minimum of 150PSI working pressure. See the top portion of figure 1.

Flanged pipe secondary containment:

For this design a custom made flange will be made to blank flange the existing flanged pipe.

See the bottom half of Figure 1 and figure 2 below

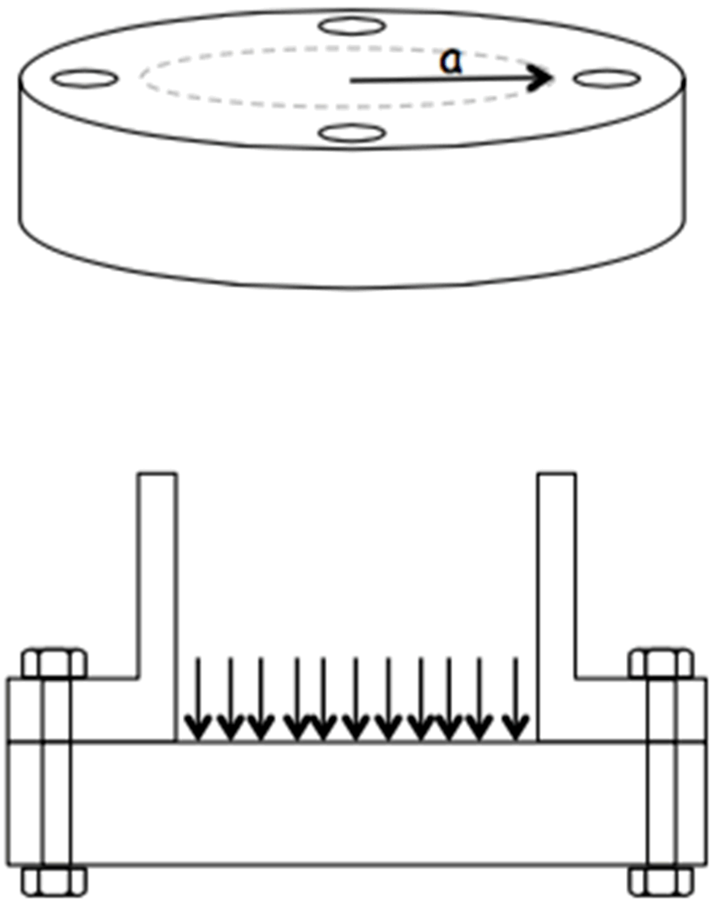

Figure 2

Flange material : XL-10 Lexan material from GE Plastics. This material has a flash point of 873F°. The XL type has a coating that provides a ten year warrantee against yellowing due to UV light.

Properties of GE Lexan XL10 sheet:

½" thick
Diameter =7.5" (standard 3" pipe flange)
Pressure diameter = 1.913"
Ultimate flexural strength ∂_U= 13,500 PSI say 10,000 psi

Roark's Formula, 6th edition, Table 24, Case 10b, pg 429

Diala Oil specific gravity	G	.91max		
Thickness	t(in)	.5		
Distributed pressure	q (psi)	2.17	= 5.5' * .433 psi/ft * G	say 3 psi
Disk radius	a (a)	.9565		say.96 in^2
Poisson's Ratio	v	.3		
Unit moment in center	M (in-lb)	.22	$=qa^2 (1+v)/16$	

Max Stress ∂ (PSI) 5.34 $=6M/t^2$, pg 398

Safety factor 1873 $= \partial_U/\partial_{max}$, OK

½" Lexan XL10 blank flange is more than structurally adequate.

Gasket material

Gasket material is initially selected as 1/16" Viton
Viton was verified to be compatible with Diala oil per Mykin Inc. Seal compatibility table.
Viton has exceptionally good resistance to atmospheric oxidation, sun and weather
Viton Maximum Crush 45% Seal and design Inc. Viton F 70%
Viton Minimum compression to assure a seal 5%
Viton Modulus of elasticity $E_G = 116$ PSI (MatWeb)

PSI
P_{min} for Viton = E_G 5% = 116x .05 = 5.8 PSI

Area of gasket: $3.14 * 3.5^2 - 3.14 * .957^2 = 35.6\ in^2$
The total force is 5.8 PSI * 35.6in
$P_{pessure}$ = 206lb @5% compression Say 400lb at 10% compresion

Bolt torque:

Torque bolts to provide gasket compression of 10% compresion. 5% is minimum compression, 40% is maximum. Don't want to take all the way to 40%, to minimize the chance of splitting the gasket by over compressing it.

T_{bolt} = Bolt Torque	
K = Torque coefficient	.2 for plain untreated
D = Nominal bolt diameter	.75"
F_{bolt} = Force on a bolt=400/4 bolts =	100lb

$F_{bolt} = T_{bolt} / KD$ (Spaenaun)

$T_{bolt} = F_{bolt} KD = 100lb/ .2 \times .75in = 667\ inlb = 4.63\ ftlb$ Say 5 ft-lb

Minimum torque required to ensure a secure bolt is 4 ft-lb (Portland Bolt & Manufacturing Company)

Torque to 5 ft-lb

Installation

Before the piping changes can be made the tank must be drained to below the bottom of the lowest of the three pipe stub outs. Once the tank is drained the existing piping can be removed from the stub outs. The three stub outs are to be wiped clean with clean cloths and then further clean with alcohol wipe.
Operational piping modifications will be made in accordance with LLNL plumbing and piping requirements.
With the stub outs cleaned the pipe plugs can be inserted. The plugs are to be inserted to the primary tank end of the stub out (See figure 1). With the plug in place the compression nut are to be tightened to the manufacturers designated torque.

Once the pipe plugs are in place and tested, it is time to create the new piping secondary containment.
For two of the stub outs Thread on the appropriate piping coupling and view port.
For the third stub out install the new Lexan flange using a Viton gasket and torqueing the bolts to 5 ftlb.

Leak Test

The tank T1-A3 re-piping does not modify the tank in any way. Therefor STI SP031 is not invoked. UL-142 requires performance testing of the primary and secondary containment systems of tanks. The tank manufacture indicated since the tank is not being modified there is no reason to retest the existing primary tank containment. "LLNL may do what it wants with the stub outs and may test the piping as it sees fit."
The STI consultant, while acknowledging a lack of a firm requirement, recommended pressure testing the primary tank, as a conservative approach for SPCC or regulatory purposes . This would involve hiring a tank testing company and sealing all primary tank connections and ports, including disabling pressure relief safety devises (i.e. bolting down the man way hatch). Pressure testing the primary containment would require more piping work to blind flange openings and connections.

In the absence of any hard requirements to retest the primary tank, and the added expense and time delay involved, an alternate approach is presented. This approach is in accordance with UL-142 section 39.3.3 which states: "As an option to the leakage test described in 39.3.2 and 39.3.3, the annular space may be tested by applying a vacuum of at least 13 inches of mercury for a minimum of 12 hours. If the tank is unable to maintain the vacuum (plus or minus 2 inches of mercury) for the specified time, the tank shall be retested using the method described in 39.3.2 and 39.3.3. " This approach tests both the primary and secondary tank systems at the plug.

<u>Threaded stub outs:</u>

Perform a vacuum test as follows: After installing the pipe plugs and prior to installing the view port install a test fitting with a Schrader valve and vacuum gage. In accordance with UL-142, draw a vacuum in the newly formed pipe secondary containment of 13 inches of mercury (-6.4psi). Over the course of 12 hours observe the pressure. If the tank is unable

to maintain the vacuum (plus or minus 2 inches of mercury (1psi)) for the specified time, confirm and correct sealing of test apparatus and repeat the test. If the test still cannot be passed stop work.
Once the test is passed install the secondary containment fittings and view port.

<u>Flanged Stub out:</u>

Perform a vacuum test as follows: After installing the pipe plugs and prior to installing the view port install a test fitting with a Schrader valve and low pressure vacuum gage. Draw a vacuum in the newly formed pipe secondary containment of 13 inches of mercury (-6.4psi). Over the course of 12 hours observe the pressure. If the tank is unable to maintain the vacuum (plus or minus 2 inches of mercury (1psi)) for the specified time, confirm and correct sealing of the test apparatus and repeat the test. If the test still cannot be passed stop work.
Once the test is passed install the secondary containment Lexan view port flange.

References:

Federal:
Title 40, Chapter 1, Subchapter D, Part 112, Subpart A, 112.1
Title 40, Chapter 1, Subchapter D, Part 112, Subpart A, 112.2
Title 40, Chapter 1, Subchapter D, Part 112, Subpart B, 112.8

LLNL:
DES 2754 00 Petroleum Product Storage in Tanks

Industry Standards:
American Petroleum Institute, Standard 650
API Specification 12F, Specification for Shop Welded Tanks for Storage of Production Liquids
Steel Tank Institute, R912, Shop Fabricated Stationary Aboveground Storage Tanks For Flammable, Combustible Liquids Installation Instructions

Steel Tank Institute, SP001-00, Standard for inspection of in-Service shop fabricated aboveground tanks for storage of combustible and flammable liquids.

Steel Tank Institute, SP031, Standard for Repair of Shop-Fabricated aboveground Tanks for the Storage of Flammable and Combustible Liquids
Underwriters Laboratory 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.