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March 13, 2013

VIA COURIER

Western Engineered Containment Ltd. #5, 119 - 39015 Hwy 2A Red Deer, Alberta T4S 2A3

Attention: Mr. Arnold Baker

Dear Sir:

Re:

Containment System Analysis Your File No.: Arnold Baker Our File No.: 13-01-16176

Please find my analysis of your containment system. The optimum number of braces were analysed in ANSYS FEA software.

The containment system is for use around temporary tanks. This containment system does not meet the fire prevention requirements for a permanent tank installation as discussed. Analysis of this system demonstrates that it has been designed as a temporary structure and there is very little room for reducing weight in the structure.

This table shows the minimum number of braces required for the system to be satisfactorily supported as a temporary structure and the number of braces has previously been optimized for this application. Without increasing the material thickness of the containment walls, the number of vertical braces cannot be reduced.

Wall Height (in)	Specific Gravity (SG) of Contained Fluid	# of Braces Per Full Wall Panel
22	SG = 1.34</td <td>3 braces for every 2 wall Panels</td>	3 braces for every 2 wall Panels
33	SG = 1.0</td <td>3 braces for every 2 wall Panels</td>	3 braces for every 2 wall Panels
33	1.0 < SG = 1.34</td <td>3</td>	3
44	SG = 1.0</td <td>2</td>	2
44	1.0 < SG = 1.34</td <td>3</td>	3

The numbers of vertical braces are a function of the wall height of the containment system and the specific gravity of the contained fluid.

The analysis was done using ANSYS FEA software and consisted of hydrostatic loading.

Sincerely,

ALLAN R. NELSON ENGINEERING (1997) INC.

Bob W. Johansson, P.Eng.

ARN/cn

Enclosure – Report

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**MARCH 13, 2013** 

**OUR FILE NO.: 13-01-16176** 

YOUR FILE NO.: ARNOLD BAKER

# REPORT ON CONTAINMENT SYSTEM ANALYSIS FOR WESTERN ENGINEERED CONTAINMENT LTD.

Prepared By: Bob W. Johansson, P.Eng.

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### 1.0 INTRODUCTION

We were requested to do a design review of a secondary containment system, which is used as a substitute for an earth dike surrounding a tank to contain fluid in the event of tank rupture.

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In Alberta the installation of above ground storage tanks in tank farms is regulated by The Petroleum Tank Management Association of Alberta (PTMAA). This organization also regulates the secondary containment used to contain accidental spills.

### 2.0 DISCUSSION

The analysis of the secondary containment system was done using ANSYS Finite Element Analysis software, as well as closed form analysis. Western Engineered Containment Ltd. (Western) provided drawings of the components, which constitute the various assembly configurations of the system. The system cannot be considered to be a tank or pressure vessel so the allowable applied stresses on the components are provided in the structural steel code. The allowable applied stress on the containment system would thus be sixty percent of the material of constructions' yield strength. The containment system walls are constructed of ASTM A653 SS Grade 50 Class 1 steel (Appendix G), which has yield strength of 50 ksi; thus, the maximum allowable applied stress would be 30 ksi.

The loading on the containment system is from hydrostatic pressure, which is a function of the contained fluids depth and specific gravity. The pressure acts normal to any submerged surface.

## Excerpt - Petroleum Tank Management Association of Alberta - Secondary Containment to Contain Accidental Spillage

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Secondary containment can be achieved by using a double wall tank or a single wall tank placed in a conventional dike system. The walls and base of a conventional dike shall be made of non-combustible materials and provide a permeability of not more than 10-6 cm/sec. Impermeable dike liners conforming to ULC/ORD - C58.9 standards for the base of the dike to achieve the impermeability. The liner must also be covered with a non-combustible material and thickness (sand or gravel) to prevent failure if exposed to fire. The total dike area shall be constructed to accommodate spilled product. Single tanks placed in a dike must be capable of containing 110% capacity of the tank. If there is more than one tank, the volumetric capacity of the dike would be the volume of the largest tank. If there is more than one tank, the volumetric capacity of the dike would be the volume of the largest tank plus 10% of the capacity of the largest tank or 10% of the aggregate capacity of all remaining tanks, whichever is greater. Dike walls shall be placed in no less than 1.5 meters from the tank outer shell. Containment areas should not permit an accumulation of precipitation or liquids. A low point in the secondary containment shall be used to draw liquid from the containment area in a safe manner. The contained space shall not be used for storage purposes.

### What kind of Secondary Containment is Required?

All aboveground storage tanks require secondary containment to contain accidental spillage. There are two ways of attaining secondary containment on aboveground storage tanks. Single wall tanks are placed in a conventional dike system to contain accidental spillage where the walls and base are made of non-combustible material providing a permeability of not more than 10-6 cm/sec. The capacity of the secondary containment area is important. If there is only one tank the dike must be capable of containing 110%

of the capacity of the tank. If there is more than one tank, the volumetric capacity of the dike must be the capacity of the largest tank plus 10% of the capacity of the largest tank or 10% of the aggregate of the remaining tanks, whichever is greater. Dike walls must be no less than 1.5 meters from any tank shell. The second type of aboveground tank secondary containment is of the double walled variety or contained tank assembly. Some tanks which are listed in Article 4.3.1.2 of the Fire Code are permitted without a conventional dike system. Aboveground storage tanks raised off the ground more than 300 mm must have support, which has a fire-resistance rating of not less than 2 hours. An example of product that provides such resistance is concrete.

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### **Temporary Tanks (Excepts)**

The PTMAA often learns of storage tanks which are intended to be moved around on a particular job site or to another location all together. The Fire Code exempts tanks on "isolated construction projects". "Such tanks may include isolated construction sites and earth-moving projects, including gravel pits, quarries, and borrow pits, where in the opinion of the Authority Having Jurisdiction, it may not be necessary to comply with the more restrictive requirements of Part IV". Such tanks would also not have to be registered with the PTMAA. The Fire Code does not define "temporary" in terms of time. Tanks do not have to be registered if it is known the tank would not be used for more than one year. The PTMAA applies the one year maximum for temporary construction projects, as well.

Having a "temporary" facility does not mean you are permitted to operate a less-safe facility. Companies that install temporary fuelling for their construction, mining, forestry site, etc., are likely to use a double-walled storage tank. Farm tanks on stands are not permitted by the Fire Code and strongly discouraged from use within any business sector.

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It is unrealistic to expect a temporary tank to be installed on a cement pad, but the foundation would obviously have to support a full tank's weight. It is not expected that a

temporary construction tank would be installed with emergency shutdown capabilities

away from the dispensing area. Where equipment and vehicles are being fuelled it

should be anticipated that there will be fuel spills so a clay material should be compacted

to prevent spilled product from getting off-site or to the groundwater. Hose retractors

should be installed and maintained to prevent hoses from getting driven over or ripped

off. The tank and dispenser should be protected from being hit by heavy equipment using

jersey barriers that can be easily re-located. The tank contents should be clearly indicated

and there should be a 40BC fire extinguisher at the tank site.

Another common inquiry is with respect to mobile fuel tanks. These tanks are mounted

on a trailer and pulled to equipment needing to be re-fuelled. Mobile tanks are not

governed by the Fire Code. The relevant legislation for these tanks is the Dangerous

Goods Transportation & Handling Regulation.

**End Excerpts** 

3.0 ANALYSIS RESULTS

The loading on the structure is from hydrostatic pressure so correspondingly it is found

that the applied stress at the top of the containment system is very small and the

maximum applied stress occurs at the bottom of the structure where the highest

hydrostatic pressure occurs.

This table (Table 1) is optimised for this containment application. The structure is

temporary in nature and has been optimized to its minimum allowable strength. The

vertical braces are necessary to keep the walls from yielding when the containment system is full of fluid.

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**Table 1: Containment Bracing** 

Wall Height (in)	Specific Gravity (SG) of Contained Fluid	# of Braces Per Full Wall Panel
22	SG = 1.34</td <td>3 braces for every 2 wall Panels</td>	3 braces for every 2 wall Panels
33	SG = 1.0</td <td>3 braces for every 2 wall Panels</td>	3 braces for every 2 wall Panels
33	1.0 < SG = 1.34</td <td>3</td>	3
44	SG = 1.0</td <td>2</td>	2
44	1.0 < SG = 1.34</td <td>3</td>	3

### **Bolts**

The question out forward to us is can we use  $\frac{5}{16}$  Grade 8 bolts instead of  $\frac{3}{8}$  Grade 8 bolts? The shear loads applied to the bolts varies from almost no load at the top of the containment wall to a maximum shear load of:

- 1)  $1,764 \text{ lbf} / 0.0524 \text{ in}^2 = 33.6 \text{ ksi for } 5/16 \text{ bolt}$
- 2)  $1,764 \text{ lbf} / 0.0775 \text{ in}^2 = 22.8 \text{ ksi for } 3/8 \text{ bolt}$

The loads on the bolts are acceptable and the bolt size could be reduced to  ${}^{5}/_{16}$  in Grade 8 bolts. The tensile strength s of a Grade 8 bolt is 74 ksi. Allowable applied shear strength of a bolt can be approximated using sixty percent of the tensile strength, this would be a value of 44.4 ksi so a to  ${}^{5}/_{16}$  inch bolt is satisfactory for this application.

The clamping load and applied torque on the bolts should be:

- 1) <sup>5</sup>/<sub>16</sub> Grade 8 bolt clamp load: 4,700 lbs. when torqued to 24 lb-ft. (dry).
- 2) <sup>3</sup>/<sub>8</sub> Grade 8 bolt clamp load: 6,980 lb. clamp load when torqued to 45 lb-ft.

### **Base Material**

The material of construction of the containment walls is ASTM A653 SS Grade 50 Class 1 G115 PASS OILED. This material is zinc costed sheet steel with a minimum yield sternght of 50 ksi. The term "G115" is an indicator of how much zinc has been applied to the steel. It means that 1.15 oz of zinc has been applied to the surface of the material every square foot.

### 4.0 CONCLUSION

The containment design as provided is designed to use a membrane to provide secondary containment. If a membrane provides the secondary containment it shall conform to ULC/ORD-C58.9. The strength of the containment walls is just enough to hold the contained fluid. The diameter of the bolts could be reduced from  $\frac{3}{8}$  in Grade 8 bolts to  $\frac{5}{16}$  in Grade 8 bolts. The bolt spacing in the panel joints could be optimized by spacing the bottom bolts closer together with the spacing increasing as the bolts more upwards in the joint. This bolt distribution would more closely match the hydrostatic pressure distribution applied to the containment wall.

PERMIT TO PRACTICE

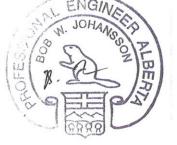
Allan R Nelson Engineering (1997) Inc.

Signature

Date 13 Mar 2013

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The Association of Professional Engineers,
Geologists and Geophysicists of Alberta



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