

**1RF – 454**

**Zia Hills (Superman)  
Recycling Facility and  
Containment**

**Application  
Volume 3**

**Conoco Phillips  
October 16, 2020**

## **Volume 3**

### **Variances for C-147 Registration Package for Zia Hills Containment and Recycling Facility Section 30, T26-S, R32-E, Lea County**

- Variances for In Ground and AST Recycling Storage Containments**
- Engineering Variances for In-Ground and AST Storage Containments**
- Applicability of Engineering Variances to Variety of Site Conditions in Permian Basin**



*Aerial view showing in-ground containments designed by Magrym Consulting and permitted by Hicks Consultants. Also shown are two 60,000 bbl above-ground storage tank containments permitted by Hicks Consultants. Photograph by permission from Magrym Consulting.*

**Prepared for:  
Conoco Phillips Company**

**Prepared by:  
R.T. Hicks Consultants, Ltd.  
901 Rio Grande NW, Ste F-142  
Albuquerque, New Mexico 87104**

## **Variances and/or Equivalency Demonstrations for Recycling Storage Containments**

- **Game/Chain Link Fencing in lieu of 4-strand barbed wire**
- **Avian Protection Plan in lieu of netting**
- **Delay in fluid removal during active stimulation in lieu of within 48 hours.**
- **Delay in closure if less than 20% fluid used in 6 months**

## ***Fencing Variance Request for In Ground Containments***

## **FENCING VARIANCE FOR PRODUCED WATER CONTAINMENTS**

### **9.15.34.12 D Fencing**

#### **Statement Explaining Why the Applicant Seeks a Variance**

**The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of NMAC 9.15.34.12 D**

**D. Fencing.**

- (1)** The operator shall fence or enclose a recycling containment in a manner that deters unauthorized wildlife and human access and shall maintain the fences in good repair. The operator shall ensure that all gates associated with the fence are closed and locked when responsible personnel are not onsite.
- (2)** Recycling containments shall be fenced with a four-foot fence that has at least four strands of barbed wire evenly spaced in the interval between one foot and four feet above ground level.

**The applicant proposes use of game fence, chain link fence or other fence to deter wildlife access as prescribed by design engineer.**

Because feral pigs, javelina and deer are present in the Permian Basin of Chaves, Eddy and Lea Counties, a chain link or game fence is required in order to comply with Section 19.15.34.12 D.1 of the Rule. The specification for fencing provided in 19.15.34.12 D.2 contradicts D.1 because pigs will move beneath the lower strand of a 4-strand, 4-foot high barbed wire fence and deer will jump over. Thus, compliance with D.2 results in a violation of D.1. Compliance with D.1 is the critical component of the Rule.

#### **Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment**

The operator will provide for a fence to enclose the recycling containment in a manner that deters unauthorized wildlife and human access better than what is defined in the rule. The operator will employ a game fence, chain link or other fence as prescribed by the design engineer rather than a four-foot fence with interval strands, in order to better deter wildlife from passing under, through or over that barrier.

***Variance to Install Bird-X Mega Blaster Pro as primary  
Hazing Program for Avian Species (see product specs  
in Volume 1)***

## **AVIAN PROTECTION PROGRAM FOR PRODUCED WATER CONTAINMENTS**

### **19.15.34.12 E – Netting**

#### **Statement Explaining Why the Applicant Seeks a Variance**

**The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections NMAC 19.15.34.12 E**

**E. Netting.** The operator shall ensure that a recycling containment is screened, netted or otherwise protective of wildlife, including migratory birds. The operator shall on a monthly basis inspect for and, within 30 days of discovery, report the discovery of dead migratory birds or other wildlife to the appropriate wildlife agency and to the division district office in order to facilitate assessment and implementation of measures to prevent incidents from reoccurring.

**The operator proposes use of avian hazing protocol in lieu of netting for in-ground produced water storage containments.** The reason for requesting these variances has been two-fold:

1. The capital and O&M cost of the proposed hazing system is significantly less than netting, especially for very large (e.g. > 100,000 bbls total capacity) containments. Increased cost can cause operators to employ fresh water in lieu of recycling produced water where storage is essential.
2. Placement of support structures within large containments can, if the structures fall or fail, create a leak in liner system.

The operator will install and use the Bird-X Mega Blaster Pro as a primary hazing program for avian species. In addition to this sonic device, staff will routinely inspect the containment, at least weekly, for the presence of avian species. Decoys of birds of prey are placed on the game fence and other roosts around the open water to provide additional hazing.

#### **Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment**

This effective alternative to netting will provide an economic incentive for operators to store and utilize produced water recycling in lieu of fresh water. This system may also reduce the risk of liner damage related to netting support structures within the containments.

***Variance Request to Delay Removal of Fluid (post leak detection) During Active Stimulation***



# **STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE TO REPAIR LINER DAMAGE AND/OR REMOVE FLUID FROM THE PRODUCED WATER CONTAINMENT WITHIN 48 HOURS DURING HYDRAULIC STIMULATION WITH TREATED PRODUCED WATER**

## **Statement Explaining Why the Applicant Seeks Variance**

**The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of NMAC 19.15.34.13**

### **NMAC 19.15.34.13 OPERATIONAL REQUIREMENTS FOR RECYCLING CONTAINMENTS:**

**B. (4)** If the containment's primary liner is compromised above the fluid's surface, the operator shall repair the damage or initiate replacement of the primary liner within 48 hours of discovery or seek an extension of time from the division district office.

**(5)** If the primary liner is compromised below the fluid's surface, the operator shall remove all fluid above the damage or leak within 48 hours of discovery, notify the division district office and repair the damage or replace the primary liner.

**The applicant is requesting a variance for to allow more than 48 hours to repair the primary liner and remove fluids from the containment during hydraulic stimulation with treated produced water.**

When a stage of hydraulic stimulation of a horizontal well commences, ceasing stimulation in the middle of a stage can harm the productive capacity of the well, thereby causing waste of the resource. During active hydraulic stimulation of horizontal wells, significant activity is occurring at the containment throughout and between each stage of stimulation. This activity is not only staff working to keep pumps operational and maintaining the rate of water flow to the well, but also continually filling the containment to prepare for the next stage of stimulation. In order to safely accommodate the 48-hour mandate of the Rule, stimulation activities would need to cease to allow repair of the liner or removal of the water, presumably to the adjacent in-ground containment. Cessation of all activities would be expensive and, as outlined below, provide minimal value.

## **Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment**

During hydraulic stimulation, the leak detection/pump-back system will be monitored weekly, as prescribed by the Rule. If a leak is detected, the operator immediately begins pumping to minimize the hydraulic head on the secondary liner caused by the leak, in accordance with the Operations and Maintenance Plan of the approved permit/registration. This pumping can and will occur during hydraulic stimulation activities. The District Office will be notified of the leak as prescribed by the Rule.

With the active pumping and minimization of hydraulic head on the secondary liner, seepage into underlying earth material, if a breach in the secondary liner also exists, is minimal. In the absence of a breach in the secondary liner, seepage to earth material is

zero. Hydraulic stimulation of a horizontal well typically requires 2-5 weeks. Thus, the primary liner can and will be repaired when stimulation activity ceases, but no longer than 5 weeks from the date of discovery. Five weeks of minimal seepage will not, with reasonable probability, cause impairment of groundwater quality at the Zia Hills recycling containments.

***Variance to Cessation of Operation Defined by Using  
Less Than 20% of Total Capacity of Containment for a  
Period of Six Months.***

## **STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE TO CESSATION OF OPERATION DEFINED BY USING LESS THAN 20% OF THE TOTAL CAPACITY OF THE CONTAINMENT FOR A PERIOD OF SIX MONTHS**

### **Statement Explaining Why the Applicant Seeks a Variance**

**The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections NMAC 19.15.34.13 C and 19.15.34.14**

**19.15.34.13 C.** A recycling containment shall be deemed to have ceased operations if less than 20% of the total fluid capacity is used every six months following the first withdrawal of produced water for use. The operator must report cessation of operations to the appropriate division district office. The appropriate division district office may grant an extension to this determination of cessation of operations not to exceed six months.

**19.15.34.14 A.** Once the operator has ceased operations, the operator shall remove all fluids within 60 days and close the containment within six months from the date the operator ceases operations from the containment for use. The division district office may grant an extension for the removal of all fluids not to exceed two months. The division district office may grant an extension to close the containment not to exceed six months....

### **The reason for requesting a variance from this portion of the Rule is:**

The facility and in-ground containments are under construction and scheduled for installation of the liner system in May. Market conditions have caused ConocoPhillips to postpone hydraulic stimulation of wells until 2021. At present, not lining the containment is not an option due to contractual mandates with the construction firm. Therefore, ConocoPhillips plans to place several feet of treated water into the containments to hold the liners in place pending filling for the 2021 E&P activities. Therefore, closure of the containments in December or May 2021, as prescribed by the Rule, does not make economic or environmental sense and will not promote preservation of fresh water resources.

Market conditions in the future may also cause a pause in hydraulic stimulation of ConocoPhillips wells. If that time arises, ConocoPhillips will make this same request again.

### **Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment**

Because the containments will contain treated water, weekly and monthly inspections in accordance with the permit application/registration will occur. If the leak detection/pump back system identifies a compromised primary liner, ConocoPhillips will report the breach in accordance with the permit and Rule. We believe that the 2-liner system with pump-back of any inter-liner water is sufficiently robust that granting this variance does provide equal protection of groundwater. The liners are also sufficiently robust to maintain integrity for many years beyond the anticipated time between completion of the containments and initiation of hydraulic stimulation in 2021.

March 2020

## **Variances and/or Equivalency Demonstrations for In-Ground Recycling Storage Containments Liners**

*BLM is requiring that 60-mil HDPE is used as secondary liner for inground containment facility at this site. It's use is addressed in Transmittal letter in Volume 1*

## **STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE FOR 60-MIL HDPE LINER AS AN ALTERNATIVE SECONDARY LINER FOR IN GROUND RECYCLING CONTAINMENT**

### **Statement Explaining Why the Applicant Seeks Variance**

**The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of 19.15.34.12**

**NMAC 19.15.34.12 A. DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT**

**(4)** All primary (upper) liners in a recycling containment shall be geomembrane liners composed of an impervious, synthetic material that is resistant to ultraviolet light, petroleum hydrocarbons, salts and acidic and alkaline solutions. All primary liners shall be 30-mil flexible PVC, 45-mil LLDPE string reinforced or 60-mil HDPE liners. *Secondary liners shall be 30-mil LLDPE string reinforced or equivalent with a hydraulic conductivity no greater than  $1 \times 10^{-9}$  cm/sec.* Liner compatibility shall meet or exceed the EPA SW-846 method 9090A or subsequent relevant publications.

**The applicant is requesting a variance for the use of proposed 60-mil HDPE as a secondary liner in place of the 30-mil LLDPE string reinforced liner recommended in Rule 34.**

*This is specifically required by BLM for this project.*

### **Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment**

The requirement by BLM to utilize 60-mil HDPE as a secondary liner will provide equal or better protection of fresh water, public health and the environment than the requisite 30-mil LLDPE string reinforced liner. This same liner is advised per rule 34 as a primary liner which is exposed to more significant environmental and chemical stressors than a secondary liner, *thus, its use also as a secondary liner provides more than the requisite protection.* Siting criteria and stamped plans from design engineer confirm applicability of this liner system to this specific site. A technical memorandum provides clarification that the engineering requirements for site preparation, which ensures functionality of the liner system, is crosscutting to varied locations within the Permian Basin.

March 2020

***Applicability of Variances for In Ground Recycling  
Containments in the Permian Basin of New Mexico***

**R.K. FROBEL & ASSOCIATES**  
*Consulting Engineers*

January 20, 2020

Mr. Randall Hicks, PG  
R.T. Hicks Consultants Ltd.  
901 Rio Grande Blvd NW  
Albuquerque, New Mexico 87104

RE: Applicability of Variances for In Ground Lined Containments in the Permian Basin of New Mexico

Dear Mr. Hicks:

At your request, I have reviewed the historical variances for In Ground Containments in the document titled “Variances for C-147 Registration Packages Permian Basin of New Mexico” (January 2020) and examined the applicable design drawings and permits for the following In Ground containments:

- C-147 Registration Package for Gamma Ridge Recycling Containment and Recycling Facility, Section 14, T24-S, R34-E, Lea County
- C-147 Registration Package for Dagger 2 Recycling Containment and Recycling Facility, Section 30, T21-S, R33-E, Lea County
- C-147 Registration Package for Landes Recycling Containment and Recycling Facility, Section 22, T25-S, T28-E, Eddy County
- C-147 Registration Package for Fez Recycling Containment and Recycling Facility Area (+ 100 acres, Section 8, T25-s, R35-E, Lea County)

Locations of the In Ground containments are in Lea and Eddy County and range from west of the Pecos River to slightly west of Jal, NM. All of the locations exhibit different surface and subsurface geology, different topography and are of various sizes and volumes. *However, as regards structural integrity of the base soils that support the geomembrane containment system, the specification requirements are the same.* The foundation soils must be roller compacted smooth and free of loose aggregate over ½ inch. Compaction characteristics must meet or exceed 95% of Standard Proctor Density in accordance with ASTM D 698. This specification requirement is specific and causes the general or earthworks contractor to meet this standard regardless of the site specific geology or topography. Provided that the design drawings and associated specifications call out the minimum requirements for subsoils compaction (i.e., 95% Standard Proctor Density – ASTM D 698), the design engineer or owners representative will carry out soils testing on the foundation materials to provide certainty to the containment owner that the earthworks contractor has met these obligations.

*Thus, provided that the contractor meets the minimum specified requirements for foundation soils preparation and density, the location, geology or depth to groundwater will make no difference as regards geomembrane liner equivalency as demonstrated by*



**R.K. FROBEL & ASSOCIATES**  
*Consulting Engineers*

the variances presented in this volume and are considered valid for meeting NMOCD Rule 34 requirements for all locations within the Permian Basin of New Mexico.

If you have any questions on the above technical memorandum or require further information, give me a call at 720-289-0300 or email [geosynthetics@msn.com](mailto:geosynthetics@msn.com)

Sincerely Yours,

*RK Frobel*

Ronald K. Frobel, MSCE, PE

References:

Section 19.15.34.12 OCD rule 34 for Impoundments  
ASTM Standards 2019



## **Variances and/or Equivalency Demonstrations for Above Ground Steel Tank Modular Recycling Storage Containments**

- **Slope and Anchor Trench**
- **Freeboard**
- **40 mil LLDPE for Primary and Secondary Liners**
- **Applicability of Variances for Modular AST  
Containments in the Permian Basin of New Mexico**

***Slope and Anchor Variance Request for Above Ground  
Steel Tank Modular Recycling Storage Containments***

## **STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE FOR SLOPE AND ANCHOR FOR MODULAR STEEL AST CONTAINMENT**

### **Statement Explaining Why the Applicant Seeks a Variance**

**The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of NMAC 19.15.34.12.**

**NMAC 19.15.34.12 DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT:**

A. An operator shall design and construct a recycling containment in accordance with the following specifications.

(2) A recycling containment shall have a properly constructed foundation and interior slopes consisting of a firm, unyielding base, smooth and free of rocks, debris, sharp edges or irregularities to prevent the liner's rupture or tear. Geotextile is required under the liner when needed to reduce localized stress-strain or protuberances that otherwise may compromise the liner's integrity. *The operator shall construct the containment in a levee with an inside grade no steeper than two horizontal feet to one vertical foot (2H:1V). The levee shall have an outside grade no steeper than three horizontal feet to one vertical foot (3H:1V).* The top of the levee shall be wide enough to install an anchor trench and provide adequate room for inspection and maintenance.

(3) Each recycling containment shall incorporate, at a minimum, a primary (upper) liner and a secondary (lower) liner with a leak detection system appropriate to the site's conditions. *The edges of all liners shall be anchored in the bottom of a compacted earth-filled trench. The anchor trench shall be at least 18 inches deep.*

**The applicant requests a variance to prescribed slope and anchor in the setting of above ground modular steel containments.**

With respect to storage of produced water for use in lieu of fresh water, Rule 34 is written for earthen, lined pits, not free-standing modular impoundments that employ liners as their primary fluid containment system. A modular impoundment consists of a professionally designed steel tank ring with vertical walls. There is no slope to consider as the segmental steel sections are set vertical.

There is no anchor trench as envisioned by the Rule, liners are anchored to the top of the steel walls with clips, no anchor trench is required.

**Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment**

The following technical memorandum provides supportive data to demonstrate equal or better protection of fresh water, public health and the environment by providing the requisite containment and protection.

**R.K. FROBEL & ASSOCIATES**  
*Consulting Engineers*

**Technical Memorandum: Slope and Anchor Trench Variance for Above Ground Steel Modular Containments**

**NMAC 19.15.34.12 A (2), (3)**

**Side Slope**

The design of soil side slope (inclination) is a geotechnical engineering design consideration. Liquid impoundments such as fresh water or process water containments are usually built within an excavation or with raised earthen embankments. For a liquid impoundment with an exposed liner system, the slope soils and construction dictate slope inclination and very detailed slope stability analysis may be required to determine if slope failure within the embankment will occur once loaded with impounded water. Slope failure may also occur during construction or when the impoundment is empty. A maximum slope is usually specified and is dependent on soil type and cohesive strength, saturated or unsaturated conditions, etc. Detailed analysis for slope stability can be found in "Designing with Geosynthetics" by R.M Koerner as well as many geotechnical books.

A modular impoundment, on the other hand, consists of a professionally designed steel tank ring with vertical walls. *There is no slope to consider as the segmental steel sections are set vertical.* Design of steel tanks, in regard to hydrostatic loading, wind loading, seismic loads, etc. are thoroughly referenced with detailed procedures in the design code - American Petroleum Institute (API) 650-98 "Welded Steel Tanks for Oil Storage". *There are no requirements for maximum slope inclination other than perhaps 90 degrees or vertical wall.*

**Anchor Trench**

All earthen impoundments with a geomembrane lining system require some form of top of slope anchor, the most common of which is an excavated and backfilled anchor trench usually set back at least 3 ft from the top of slope. Again, there are detailed procedures for anchor trench design in "Designing with Geosynthetics" by R.M Koerner.

*A Modular Impoundment requires mechanical anchoring of the geomembrane at the top of the vertical steel wall using standard liner clips that prevent the geomembrane or geomembrane layers from slipping down the side wall.* These are detailed in the Tank Installation Manual. *There are no requirements for an "anchor trench" as this is not an in-ground impoundment.*

*In summary, based on the design and specifications of a modular steel impoundment, there is no requirement for a maximum interior slope angle of 2H:1V due to the fact that this impoundment is a steel tank with vertical walls. Additionally, there is no requirement for an anchor trench as the geomembrane is attached to the top of the Modular Impoundment vertical walls with large steel clips.* This provides the requisite protection of fresh water, public health and the environment for many years.

**R.K. FROBEL & ASSOCIATES**  
*Consulting Engineers*

If you have any questions on the above technical memorandum or require further information, give me a call at 303-679-0285 or email [geosynthetics@msn.com](mailto:geosynthetics@msn.com)

Sincerely Yours,

*R K Frobel*

Ronald K. Frobel, MSCE, PE



**References:**

NMAC 19.15.34.12 DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT

American Petroleum Institute (API) 650-98 "Welded Steel Tanks for Oil Storage"

Koerner, R.M., 2005 "Designing With Geosynthetics" Prentice Hall Publishers

**Attachments:**

R. K. Frobel C.V.

***Freeboard Variance Request for Above Ground Steel Tank  
Modular Recycling Storage Containments***

## **STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE FOR FREEBOARD FOR MODULAR STEEL AST CONTAINMENT**

### **Statement Explaining Why the Applicant Seeks a Variance**

**The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of NMAC 19.15.34.13**

#### **19.15.34.13 OPERATIONAL REQUIREMENTS FOR RECYCLING CONTAINMENTS:**

**B.** The operator shall maintain and operate a recycling containment in accordance with the following requirements.

**(2)** The operator *shall maintain at least three feet of freeboard at each containment.*

**The applicant requests variance to allow for a freeboard of 2 feet as opposed to the prescribed 3 feet in the setting of an above ground steel tank modular system.**

Rule 34 did not take into consideration above ground steel tank modular containment systems. With respect to lined earthen impoundments that may hold 25-acre feet of produced water, a 3-foot freeboard stipulation makes sense. For example, wave action and other factors could focus stress on the upper portion of the levee or the liner system in these large impoundments. The smaller diameter steel tank (modular impoundment) does not share the same characteristics as these large earthen pits.

We believe 3-feet of freeboard is not necessary – especially during active hydraulic stimulation of wells when maximum storage volume provides the highest value. Moreover, meeting the 3-foot freeboard requirement at all times significantly reduces the storage capacity of a single modular impoundment – negatively impacting the economics of using produced water in lieu of fresh water for E&P activities.

### **Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment**

The attached technical memorandum by Ron Frobel, PE, describes how the proposed 2-foot freeboard limit in the permit application for the modular impoundment provides the same protection afforded by the 3-foot freeboard mandate for a large earthen pit. The attached equations and supporting email from Mr. Jason Henderson, PE, shows that a 2-foot freeboard limit on the steel impoundment meets the manufacturer's design criteria.



**R.K. FROBEL & ASSOCIATES**  
*Consulting Engineers*

**Freeboard Requirements for Above Ground Steel Tank Modular  
Recycling Storage Containments**  
**NMAC 19.15.34.13 B (2)**

Liquid impoundments such as fresh water or process water containments are usually built within an excavation or with raised earthen embankments. For a liquid impoundment with an exposed liner system, the slope soils and construction dictate slope inclination and very detailed slope stability analysis may be required to determine if slope failure within the embankment will occur once loaded with impounded water. Freeboard or the vertical height between the maximum water surface elevation and the top of slope is important for earthen impoundments. Specified freeboard requirements take into consideration high precipitation events and prevent wave run-up on slopes that result in over-topping and potential saturation of embankments. This is particularly important on large earthen impoundments. Detailed design considerations including freeboard requirements for lined earthen impoundments can be found in "Designing with Geosynthetics" by R.M Koerner as well as other publications on reservoir design.

A modular impoundment, on the other hand, consists of a professionally designed steel tank ring with vertical walls. There is no slope to consider as the segmental steel sections are set vertical. Design of steel tanks as regards hydrostatic loading, wind loading, seismic loads, etc. are thoroughly referenced with detailed procedures in the design code - American Petroleum Institute (API) 650-98 "Welded Steel Tanks for Oil Storage". *There are requirements for operational freeboard to prevent over-topping but due to the relatively small surface area and fetch of cylindrical tanks, wave heights are much less than large earthen impoundments. Thus, freeboard is usually within the range of 0.5 to 2 ft.* I have reviewed the Tank Design Calculation Summary and regarding the structural stability of the tank walls, a freeboard of 0.5 ft was assumed. Thus, the variance request of 2.0 ft for a Modular Impoundment is well within the Tank Design requirements.

*In summary, it is my professional opinion that the design freeboard of 2.0 ft will provide requisite storage volume and prevent overtopping due to wind and wave action, potential seismic events and high precipitation.*

If you have any questions on the above technical memorandum or require further information, give me a call at 303-679-0285 or email [geosynthetics@msn.com](mailto:geosynthetics@msn.com)

Sincerely Yours,

*R K Frobel*

Ronald K. Frobel, MSCE, PE

**References:**

NMAC 19.15.34.13 OPERATIONAL REQUIREMENTS FOR RECYCLING CONTAINMENTS



***R.K. FROBEL & ASSOCIATES***  
***Consulting Engineers***

American Petroleum Institute (API) 650-98 “Welded Steel Tanks for Oil Storage”

Koerner, R.M., 2005 “Designing With Geosynthetics” Prentice Hall Publishers

Attachments:

R. K. Frobel C.V.

The modular impoundment is designed for use with fluids that are 8.34 pounds/gallon (62.4 pounds per cubic foot) or lighter. Exceeding this specification for fluid weight at full tank capacity (12') could lead to failure at the connection plate(s).

Assuming a freeboard of 0.5 ft (minimum modular impoundment freeboard requirement) the Hydro Pressure (p) of water is 718 pounds per square foot (psf), where

$$\begin{aligned}
 p &= \text{Design Density} \times \text{Height} \\
 &= 62.4 \text{ PCF} \times 11.5 \text{ ft} \\
 (\text{design density} &= 8.34 \frac{\text{lb}}{\text{gal}} \times 7.48 \frac{\text{ft}^3}{\text{gal}})
 \end{aligned}$$

The density of the conditioned produced water is 9.3 pounds/gallon. Assuming a freeboard of 3-ft (19.15.17.12.F(3) NMAC) , the Hydro Pressure (p) of conditioned produced water is 626 psf, where

$$\begin{aligned}
 p &= \text{Design Density} \times \text{Height} \\
 &= 69.64 \text{ PCF} \times 9 \text{ ft} \\
 (\text{design density} &= 9.3 \frac{\text{lb}}{\text{gal}} \times 7.48 \frac{\text{ft}^3}{\text{gal}})
 \end{aligned}$$

Using conditioned produced water with the Pit Rule freeboard requirements of 3-feet results in a Hydro Pressure 92 psf less than the engineered design.

The operator asks the District Division to allow for a 2-foot freeboard, which yields a Hydro Pressure (p) of 696.4 psf, where

$$\begin{aligned}
 p &= \text{Design Density} \times \text{Height} \\
 &= 69.64 \text{ PCF} \times 10 \text{ ft} \\
 (\text{design density} &= 9.3 \frac{\text{lb}}{\text{gal}} \times 7.48 \frac{\text{ft}^3}{\text{gal}})
 \end{aligned}$$

## Andrew Parker

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**From:** Henderson, Jason E. <Jason.Henderson@CES-FluidMgmt.com>  
**Sent:** Monday, November 17, 2014 11:58 AM  
**To:** 'Andrew Parker (andrew@rthicksconsult.com)'; 'Randall Hicks' (r@rthicksconsult.com)  
**Subject:** CES - Frac Tanks New Mexico  
**Attachments:** Engineering Calculations - Pool Tanks.pdf; SKMBT\_C55013021610260.pdf; SKMBT\_C55013021807050.pdf

Randall,

These are the Pinnacle specs. If you look at the engineering calculations, provided the State requests this information, you will see the following:

Hydro Pressure,  $p = \text{Design Density} * H = 62.4 \text{ PCF} * 11.5 = 718 \text{ psf}$  – Which is the water density based on  $8.34 \text{ lb/gal} * 7.48 \text{ ft}^3/\text{gal}$

Since the state restricts me to 3 feet of freeboard then my Hydro Pressure on produced water is as follow:  
 $9.3 \text{ lbs/Gal} * 7.48 \text{ Ft}^3/\text{gal} * 9 \text{ ft} = 626 \text{ psf}$  which is 92psf less than this engineer's design thus I can use this tank for produced water under the conditions the state requires.

I could actually fill this tank to 10.3 feet with 9.3 lbs/gal produced water without comprising the engineer's design constraints. ( $9.3 \text{ lbs/Gal} * 7.48 \text{ Ft}^3/\text{Gal} * 10.3 \text{ Ft} = 715.51 \text{ psf}$  which is less than tank design max load of 718 psf)

Thank You,

Jason Henderson, P.E.  
Director, Water and Disposal Solutions  
**Complete Energy Services Water Transfer & Treatment**  
Fluid Management Division  
4727 Gaillardia Parkway, Suite 250 | Oklahoma City, OK ■ 73142  
Direct: (405) 748-2221 | Mobile: (405) 365-0952 | Fax: (405) 748-2202  
Email: [jhenderson@CES-fluidmgmt.com](mailto:jhenderson@CES-fluidmgmt.com)

March 2020

**Variances and/or Equivalency Demonstrations for  
Above Ground Steel Tank Modular Recycling  
Storage Containments (AST) Primary and  
Secondary Liners**

***40-mil Non-reinforced LLDPE Liner as Alternate  
Primary and Secondary Liners for Above Ground Steel  
Tank Modular Recycling Storage Containments***

## **STATEMENT EXPLAINING WHY THE APPLICANT SEEKS A VARIANCE FOR 40 MIL NON-REINFORCED LLDPE GEOMEMBRANE AS AN ALTERNATIVE PRIMARY AND SECONDARY LINER FOR MODULAR STEEL AST CONTAINMENT**

**The prescriptive mandates of the Rule that are the subject of this variance request are the following subsections of 19.15.34.12**

### **NMAC 19.15.34.12 A DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT**

**(4)** All primary (upper) liners in a recycling containment shall be geomembrane liners composed of an impervious, synthetic material that is resistant to ultraviolet light, petroleum hydrocarbons, salts and acidic and alkaline solutions. *All primary liners shall be 30-mil flexible PVC, 45-mil LLDPE string reinforced or 60-mil HDPE liners. Secondary liners shall be 30-mil LLDPE string reinforced or equivalent with a hydraulic conductivity no greater than  $1 \times 10^{-9}$  cm/sec.* Liner compatibility shall meet or exceed the EPA SW-846 method 9090A or subsequent relevant publications.

**The applicant proposes one layer of 40-mil LLDPE as a primary liner and a secondary liner comprised of one layer of 40-mil LLDPE material.**

Rule 34 did not consider Above Ground Steel Storage Tanks that employ liners as a primary and secondary containment method.

This material is more readily available than the prescribed liners in the Rule and provides superior flexibility and conformity characteristics. Due to the vertical steel walls, 60-mil HDPE, 45 or 30-mil LLDPE string reinforced liners and 30-mil PCV liners are not sufficiently flexible for use in these modular containments.

### **Demonstration That the Variance Will Provide Equal or Better Protection of Fresh Water, Public Health and the Environment**

The following technical documents provide supportive data to demonstrate equal or better protection of fresh water, public health and the environment by providing the requisite containment and protection. Technical comparison of the proposed material is compared to what is advised through Rule 34 is discussed. A second memorandum provides clarification that the engineering requirements for site preparation, which ensures functionality of the liner system, is crosscutting to varied locations within the Permian Basin. Stamped plans from design engineer confirm applicability of this liner system to this specific site.

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*Consulting Engineers*

**Technical Memorandum: 40-mil LLDPE as Alternative  
Primary/Secondary Liner System for Modular Steel AST Recycling  
Containment**

NMAC 19.15.34.12 A (4)

In consideration of the Primary lining application (modular AST impoundment), size of the AST and depth, design details for modular tanks as well as estimated length of up to five years of service time, it is my professional opinion that a 40 mil LLDPE geomembrane will provide the requisite barrier against processed water loss. It should be noted that the 40 mil LLDPE exceeds the OCD mandate for a Secondary lining system. *The two proposed 40 mil LLDPE liners will function equal to or better than 45 mil String Reinforced LLDPE, 30 mil PVC, or 60 mil HDPE liners as a primary liner and 30 mil LLDPE string reinforced as a secondary liner system. Additionally, the 40 mil LLDPE in a two-layer system will provide requisite protection for the environment that is equal to or better than the above primary and secondary liner systems referenced in OCD rule 34.* The following are discussion points that will exhibit the attributes of a 40 mil LLDPE lining system:

The nature and formulation of LLDPE resin is very similar to HDPE. The major difference is that LLDPE is lower density, lower crystallinity (more flexible and less chemical resistant). However, LLDPE will resist aging and degradation and remain intact for many years in exposed conditions. The LLDPE resin is virtually the same for non-reinforced 40 mil LLDPE and string reinforced 45 mil LLDPE geomembranes and both will provide requisite containment and be equally protective for this application.

Flexibility Requirements. Non-reinforced LLDPE geomembranes are less stiff and far more flexible than string reinforced geomembranes as well as 60 mil HDPE and in this regard are preferred for installations in vertical wall tanks such as this proposed installation. LLDPE provides a very flexible sheet that enables it to be fabricated into large panels, folded for shipping and installed on vertical walls transitioned to flat bottom. Non-reinforced LLDPE sheet will conform better than a string reinforced LLDPE to the tank dimensions under hydrostatic loading and will exhibit less wrinkling and creasing during and after installation.

Thermal Fusion Seaming Requirements. Thermal seaming and QC seam test requirements for geomembranes are product specific and usually prescribed by the sheet manufacturer. Both dual wedge and single wedge thermal fusion welding is commonly used on LLDPE and QC testing by air channel (ASTM D 5820) or High Pressure Air Lance (ASTM D 4437) is fully acceptable and recognized as industry standards. In this regard, either non-reinforced LLDPE or string-reinforced LLDPE will be acceptable as far as QC and thermal fusion seaming methods are concerned.

Potential for Leakage through the Primary and Secondary Liners. Leakage through geomembrane liners is directly a function of the height of liquid head above any hole or imperfection. The geonet drainage media between the primary and secondary LLDPE



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geomembranes at the base of the AST in this application provides immediate drainage to a low point or outside the Modular AST Impoundment and thus no hydrostatic head or driving gradient is available to push leakage water through a hole in the Secondary LLDPE liner .

Leakage through any Primary geomembrane is driven by size of hole and depth and will be detected by the increase of water in the drainage system and the volume being pumped out of the secondary containment. In this regard and for this variance, the Primary consists of 40 mil LLDPE geomembrane which will perform equal to or better than a single layer of string reinforced LLDPE for potential leakage. Thus, if a leak occurs through the top layer, it will be effectively contained by the second layer of 40 mil LLDPE geomembrane. If required, location of holes in the Primary can be found by Electrical Leak Location Survey (ELLS) using a towed electrode (ASTM D 7007). Holes found can then be repaired and thus water seepage into the leakage collection and drainage system will be kept to a minimum. Dependent on OCR requirements for Action Leakage Rate (ALR), the leakage volumes may only be monitored. For example, a typical ALR is < 20 gpad whereas a rapid and large leak (RLL) may be > 100 gpad. Most states specify maximum ALR values for waste and process water impoundments usually in the range of 100 to 500 gpad. However, New Mexico does not specify an ALR for waste or process water impoundments (GRI Paper No. 15).

Both non-reinforced LLDPE and string reinforced LLDPE can be prefabricated into large panels and thus both types offer the following for Containment:

- Prefabrication in factory-controlled conditions into very large panels (up to 30,000 sf) results in ease of installation, less thermal fusion field seams and less on site QC and CQA. (It should be noted that HDPE cannot be prefabricated into panels and requires considerably more on-site welding and QC).
- Large prefabricated panels will provide better control of thermal fusion welding in a factory environment that will improve the liner system integrity for the long term. Ease of installation of large prefabricated custom size panels results in a greater reduction of installation time and associated installation and QC costs
- The Non-reinforced LLDPE geomembrane provides superior lay flat characteristics and conformability which allows for more intimate contact with the underlying soil, geonet, or geotextile and tank walls as well as overlying materials thus providing better flow characteristics for drainage of water. String reinforced LLDPE exhibits more wrinkling and when overlaid or in contact with a geonet drain, wrinkles tend to form pockets and dams affecting drainage of any leakage water to the exterior of the Modular AST Impoundment.
- Both types of LLDPE geomembrane are easily repaired using the same thermal fusion bonding method without the need for special surface grinding/preparation for extrusion welding as is typically used in repair of HDPE geomembranes.

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However, string reinforced LLDPE requires that all cut edges with exposed scrim must be encapsulated with extrusion bead. No encapsulation is required on non-reinforced LLDPE.

*In summary, it is my professional opinion that the two layers of 40 mil non-reinforced LLDPE geomembranes will provide a Primary/Secondary liner system that is equal to or better than 45 mil string reinforced LLDPE, 30 mil PVC, 60 mil HDPE (primary liner) and 35 mil LLDPEr (secondary liner). Additionally, the two layers of 40 mil LLDPE will provide a superior installation and function better than liners referenced in the OCD rule. The two layers of 40 mil non-reinforced LLDPE will provide the requisite protection of fresh water, public health and the environment for at least 5 years in the frack water environment.*

If you have any questions on the above technical memorandum or require further information, give me a call at 720-289-0300 or email [geosynthetics@msn.com](mailto:geosynthetics@msn.com)

Sincerely Yours,

*R K Frobel*

Ronald K. Frobel, MSCE, PE



References:

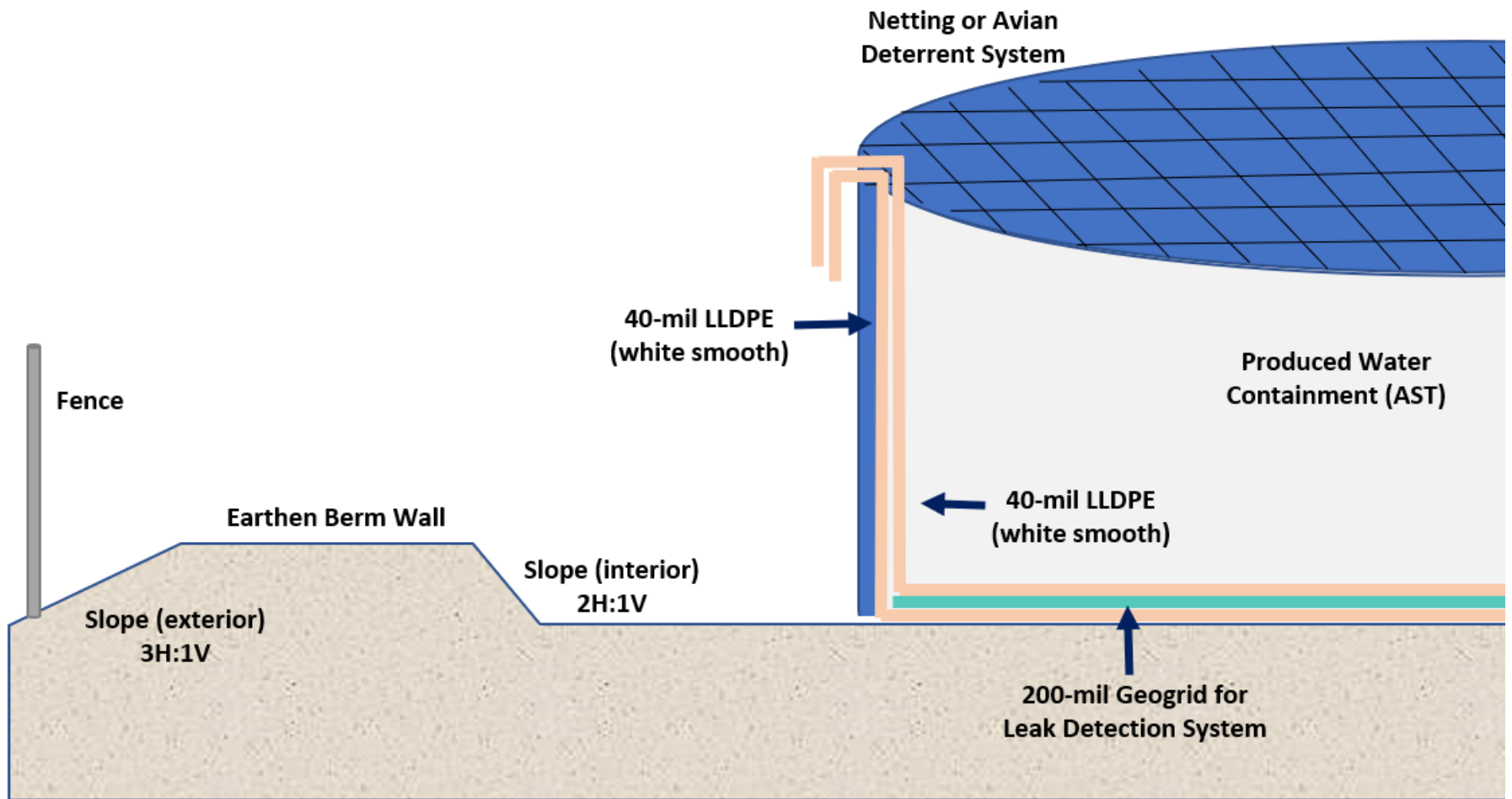
NMAC 19.15.34.12 DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A RECYCLING CONTAINMENT

Geosynthetic Research Institute (GRI) Published Standards and Papers 2018

ASTM Standards 2018

Attachments:

R. K. Frobel C.V.



January 2020

***Applicability of Variances for Modular AST Containments  
in the Permian Basin of New Mexico***

**R.K. FROBEL & ASSOCIATES**  
*Consulting Engineers*

**Technical Memorandum: Applicability of Variances for Modular AST Containments in the Permian Basin of New Mexico**  
**NMAC 19.15.34.12 A (2)**

I have reviewed the most recent historical variances for AST Containments in the document titled “Variances for C-147 Registration Packages Permian Basin of New Mexico” (January 2020) and examined the applicable design drawings and permits for the following modular AST containments located in the Permian Basin of New Mexico.

- C-147 Registration Package for Myox Above Ground Storage Tank Section 32, T25S, R28E, Eddy County (January 20, 2020)
- C-147 Registration Package for Fez Recycling Containment and Recycling Facility Area (100+ acres) Section 8, T25-S, R35-E, Lea County, Volume 2 – Above-Ground Storage Tank Containments
- Hackberry 16 Recycling Containments and Recycling Facility Section 16, T19S, R31E, Eddy County

Locations of the modular containments range from west of the Pecos River to slightly west of Jal, NM. All locations exhibit different surface and subsurface geology, different topography and are of various sizes and volumes. *However, in regard to structural integrity of the base soils that support the AST and in particular the geomembrane containment system, the specification requirements are the same.* The foundation soils must be roller compacted smooth and free of loose aggregate over ½ inch. Compaction characteristics must meet or exceed 95% of Standard Proctor Density in accordance with ASTM D 698. This specification requirement is specific and causes the general or earthworks contractor to meet this standard regardless of the site- specific geology or topography. Provided that the design drawings and associated specifications call out the minimum requirements for subsoils compaction (i.e., 95% Standard Proctor Density – ASTM D 698), the design engineer or owners representative will carry out soils testing on the foundation materials to provide certainty to the AST containment owner that the earthworks contractor has met these obligations.

*Thus, provided that the contractor meets the minimum specified requirements for foundation soils preparation and density, the location, geology or depth to groundwater will make no difference in regard to geomembrane liner equivalency as demonstrated by the AST variances presented in this volume and are considered valid for meeting NMOCD Rule 34 requirements for all locations within the Permian Basin of New Mexico.*

If you have any questions on the above technical memorandum or require further information, give me a call at 720-289-0300 or email [geosynthetics@msn.com](mailto:geosynthetics@msn.com)

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Sincerely Yours,

*R.K. Frobel*

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References:

NMAC 19.15.34.12 DESIGN AND CONSTRUCTION SPECIFICATIONS FOR A  
RECYCLING CONTAINMENT

ASTM Standards 2019



**RONALD K. FROBEL, MSCE, P.E.**

**CIVIL ENGINEERING  
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**PROFESSIONAL**

**AFFILIATIONS:** American Society for Testing and Materials (ASTM) -  
Founding member of Committee D 35 on Geosynthetics  
Chairman ASTM D35 Subcommittee on Geomembranes 1985-2000  
ASTM Award of Merit Recipient/ASTM Fellow - 1992  
ASTM D18 Soil and Rock - Special Service Award - 2000  
Transportation Research Board (TRB) of The National Academies  
Appointed Member A2K07 Geosynthetics 2000 - 2003  
National Society of Professional Engineers (NSPE) - Member  
American Society of Civil Engineers (ASCE) - Member  
Colorado Section - ASCE - Member  
International Society of Soil Mechanics and Foundation Engineers  
(ISSMFE) - Member  
International Geosynthetics Society (IGS) - Member  
North American Geosynthetics Society (NAGS) - Member  
International Standards Organization (ISO) - Member TC 221  
Team Leader - USA Delegation Geosynthetics 1985 - 2001  
European Committee for Standardization (CEN) - USA Observer  
EPA Advisory Committee on Geosynthetics (Past Member)  
Association of State Dam Safety Officials (ASDSO) – Member  
U. S. Committee on Irrigation and Drainage (USCID) - Member  
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University of Arizona: B. S. - Civil Engineering – 1969  
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**EXPERIENCE:**

R. K. Frobel & Associates - Consulting Engineers  
Evergreen, Colorado, Principal and Owner, 1988 - Present

Chemie Linz AG and Polyfelt Ges.m.b.H., Linz, Austria  
U. S. Technical Manager Geosynthetics, 1985 - 1988

U.S. Bureau of Reclamation, Engineering and Research Center  
Denver, Colorado, Technical Specialist in Construction  
Materials Research and Application, 1978 - 1985

Water Resources Research Center (WRRC), University of Arizona  
Tucson, AZ, Associate Research Engineer, 1975 - 1978

Engineering Experiment Station, University of Arizona  
Tucson, AZ, Research Assistant, 1974 - 1975

United States Navy, Commissioned Naval Officer, 1970 - 1973

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R.K. Frobel & Associates: Civil engineering firm specializing in the fields of geotechnical, geo-environmental and geosynthetics. Expertise is provided to full service civil/geotechnical engineering firms, federal agencies, municipalities or owners on a direct contract, joint venture or sub-consultant basis. Responsibilities are primarily devoted to specialized technical assistance in design and application for foreign and domestic projects such as the following:

Forensics investigations into geotechnical and geosynthetics failures; providing expert report and testimony on failure analysis; providing design and peer review on landfill lining and cover system design, mine waste reclamation, water treatment facilities, hydro-technical canal, dam, reservoir and mining projects, floating reservoir covers; oil and gas waste containment; design of manufacturers technical literature and manuals; development and presentation of technical seminars; new product development and testing; MQA/CQA program design and implementation.

Polyfelt Ges.m.b.H., Linz, Austria and Denver Colorado: As U.S. technical manager, primary responsibilities included technical development for the Polyfelt line of geosynthetics for the U.S. civil engineering market as well as worldwide applications.



U.S. Bureau of Reclamation, Denver, Colorado: As technical specialist, responsibilities included directing laboratory research, design and development investigations into geosynthetics and construction materials for use on large western water projects such as dams, canals, power plants and other civil structures. Included were material research, selection and testing, specification writing, large scale pilot test programs, MQA/CQA program design and supervision of site installations. Prime author or contributor to several USBR technical publications incorporating geosynthetics.

University of Arizona, Tucson, Arizona: As research engineer at the Water Resources Research Center, responsibilities included research, design and development of engineering materials and methods for use in construction of major water projects including potable water reservoirs, canals and distribution systems. Prime author or contributor to several WRRC technical publications.

Northeast Utilities, Hartford, Connecticut: As field engineer for construction at Northeast Utilities, responsibilities included liaison for many construction projects including additions to power plants, construction of substations, erection of fuel oil pipelines and fuel oil storage tanks. Responsibilities also included detailed review, inspection and reporting on numerous construction projects.

U.S. Navy: Commissioned Naval Officer – Nuclear Program

**PUBLICATIONS:** Over 85 published articles, papers and books.

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