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Technical Conference Paper

Update of US Gulf Coast Area Oilfield Waste Disposal Projects

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UPDATE OF US GULF COAST AREA OILFIELD WASTE DISPOSAL PROJECTS

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Abstract

Initial attempts to permit and construct salt caverns for the management of waste residues began in the early 1980's. For a variety of regulatory and political reasons, these early efforts were not successful. In the late 1980's and early 1990's, salt caverns were proposed for the management of non-hazardous oilfield waste streams (E&P wastes). Several projects have been permitted since that time and are currently operational and other projects are now in the permitting cycle. This paper gives a brief historical overview of several projects and discusses design and operational considerations of several project either in operation or have permits pending before regulatory authorities. An overview and summary of lessons learned is provided and suggested areas of future research are discussed.

Key words: Environmental Protection and Regulatory Affairs; Waste Disposal; Oil and Gas Drilling Wastes; Cavern Design; Cavern Operation; Texas Regulations; Louisiana Regulations; International Regulations; Gulf Coast of the US and Mexico

Introduction

Ever increasing energy demands on a worldwide basis has significantly increased drilling and exploration activity. Virtually every country and continent that has the potential for oil and gas deposits or has proven exploitable reserves is experiencing drilling and production activity resulting in large volumes of "oilfield wastes" which is comprised primarily of formation fluids, manufactured drilling fluids, formation cuttings and traces of oil or condensates. Countries that have regulatory programs in place for the management of these wastes streams classify and regulate these wastes in various manners. Both Europe, the UK and Mexico classify oilfield wastes as hazardous wastes (not toxic wastes) but the US classifies the fluids and cuttings produced from drilling as an exempted waste from regulation under the Resource Conservation and Recovery Act (RCRA) as amended. This does not mean that there are no regulations in regards to oilfield wastes, only that the primary federal regulatory program does not impact drilling wastes per se. The drilling wastes are considered to be non-hazardous which provides the industry in the US with considerable options in determining how the wastes will be managed.

The Gulf of Mexico is heavily explored for oil and gas both by US companies in US waters and also by Mexico through their state owned oil company PEMEX... Estimates of volumes produced off-shore Louisiana range from 10 to 15 million barrels annually whereas Texas volumes are lower, but still several million barrels. Estimates of Mexican volumes are thought to be similar to Texas. None the less both the US and Mexico (the gulf coast area) have stringent management requirements in place for oilfield wastes and are getting stricter with time. To off set the "regulatory" costs of management, the industry has spent and continues to spend time and resources on technology that can reduce costs, address specific regulatory requirements, handle large volumes and are relatively simple to implement and or operate.

Incentives for Salt Cavern Disposal

The evolution of the use of salt formations has spanned several thousands of years. Evidence has been presented previously that an early form of brine mining occurred in China over three thousand years ago. Hard rock mining of salt is well over a thousand years old (Poland). More modern methods of brine mining were developed and implemented in the early 1900s and the first serious use for hydrocarbon storage was developed in the mid-1900s. Thus we have progressed from food uses to containment of liquids and gases to now the isolation of certain products from the biosphere for geologic time periods.

One of the primary benefits of cavern disposal is that the process of receipt and injection is very cost effective. Off-shore and near shore generated wastes are usually transported to a shore location for offloading in relatively small steel containers called cutting boxes (US) or skips (UK). This transport occurs as part of the normal logistical support of a drilling rig. The off-loading occurs at a transfer station (which is under the control of the waste disposer) where the waste is aggregated into a large barge for subsequent shipment to the disposal site. This portion of the process is the same regardless of the final disposal technique. The difference at this point is that large volume vacuum or end dump trucks are loaded from the barge and driven to the cavern site where the waste is discharged into a large concrete receiving basin for resuspension of the solids and pumped directly into the cavern via a short pipeline from basin to wellhead. This does not require a segregation of different material types, a restriction on concentration of various constituents within the wastes, such as free oil or chloride concentrations, or further sizing by crushing or grinding of the product. The lack of rehandling or segregation allows for the most cost effective method on a per barrel or per ton basis than any other treatment or disposal technology.

Another incentive for cavern disposal is that at the end of the filling period of a cavern or group of caverns, the well can be plugged and abandoned in such a manner so that the waste streams are completely isolated from the surface and shallow subsurface environment. In contrast to this, shallow landfills or land farms contain the product at or near the surface which are in turn exposed to natural forces of wind, rain and other natural events. Product injected into more conventional wells (porous media), although generally highly secure, are still subject to migration within the receiving formation.

In addition to isolation from the surface environment, the product is prevented from any post closure movement within the salt formation. Although movement within most porous media may be considered small or insignificant, movement of fluids containing high solids contents may be considerable in caprock or other under-pressured formations. This movement may be such that the product could move out of the zone under the control of the operator resulting in non-compliance of permit conditions or potential legal action from adjacent property owners.

Existing and Proposed Gulf Coast Projects

The gulf coast area for the purposes of this paper extends from the Yucatan Peninsula in Mexico to the western coastline of the state of Florida in the US. The existing and proposed projects discussed herein are all in the United States. Mexico will be discussed later in the paper.

The one existing and operational project discussed herein is located in the state of Texas approximately mid-way between Houston and Beaumont, Texas. See Figure 1

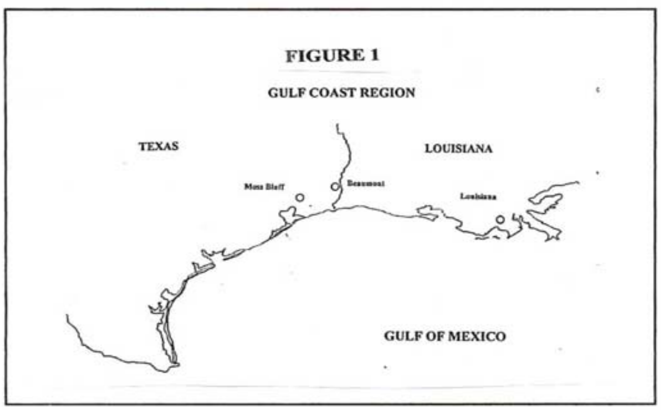
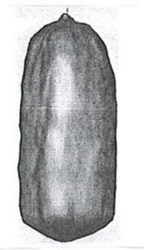


FIGURE 1

GULF COAST REGION

The cavern that is located on the site was originally developed as a brine well to supply saturated brine to a sulfur mining operation as part of the Frasch Process used in the mining. The cavern was initially drilled in 1968 and was mined for over 10 years. There is no information available on the circulation rates during this time period since the mine was closed down and dismantled in the 1980s time period and the records have not been retained. The cavern was re-entered with a new well and sonared to determine its volumetric capacity. The sonar indicated a volume of 6.2 million standard barrels. The cavern size and shape is shown on Figure 2.

FIGURE 2



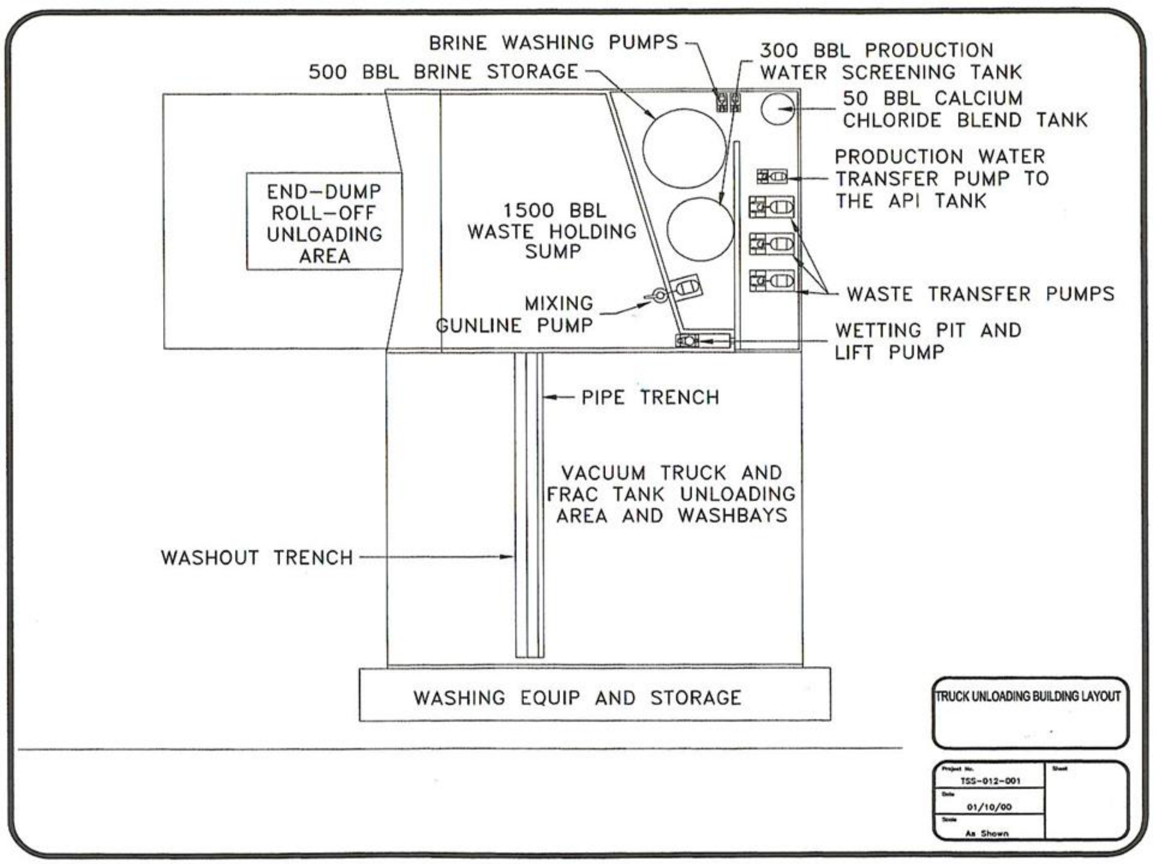
The height of the cavern is approximately 800 feet and has a diameter of approximately 350 feet. The top of the roof is 1410 feet below ground surface (bgs).

Surface receiving facilities consist of a covered concrete truck receiving slab and wash out area, a concrete receiving basin with concrete approach ramps, an office and test laboratory, equipment storage areas, steel waste transfer line to wellhead and some brine storage tanks. The common driveway, parking and facility grounds are built up to divert run on of rainfall and graded to control the location and direction of rainfall run off. The design philosophy was to minimize external environmental impact and control to the extent possible on site events.

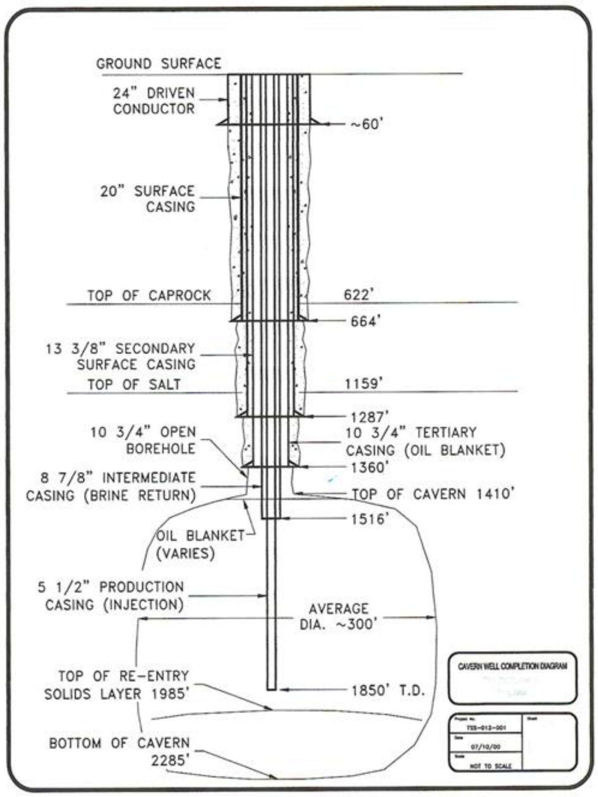
The site is located about 25 miles from the closest available dock capable of managing the large hopper barges used to transport the waste from the initial receiving transfer stations to the disposal site. This distance requires that the waste be off-loaded from the barge, placed in trucks and transported to the site. The trucks are off-loaded into the receiving basin where brine is added as may be necessary to resuspend the solids found in the waste stream. Because of the potential volume of truck traffic, the receiving facilities were placed close to the public access road (about 2600 feet from the cavern wellhead) which then required the installation of the transfer pipeline.

The key components of the receiving facility are the covered concrete truck receiving slab and the concrete basin. The slab provides fro protected unloading of liquid fill trucks and for wash out of all trucks after unloading. The basin is primarily below ground so that end dump trucks with solids can unload and be mixed with brine. This suspension of material is pumped up into the centrifugal transfer pumps using submersible pumps and then transferred to the disposal cavern. Figure 3 illustrates the surface facility layout.

FIGURE 3



The new re-entry well into the cavern was designed to accommodate high volumes of wastes. The cavern was permitted to receive up 15,000 barrels per day on a 24 hour basis (437 gpm or 1.6 m3/min). Instantaneous rates higher than these levels are common due to the addition of brine to the raw waste received. Injection pressures of less than 300 psig are normal recorded at the transfer pumps. Pressures at the wellhead are less... To achieve these rates the injection tube was sized at 5 ½ inch OD which is suspended inside a 8 5/8 inch tube which in turn in suspended within the last cemented string which is 10 ¾ inch. Figure 4 is attached which illustrates the as built configuration of this cavern.



Beaumont Area Cavern. Based on both the technical and commercial success of this first disposal cavern, another cavern was located in the Beaumont, Texas area which was judged to be suitable for waste disposal. Lessons learned from the operations of the Moss Bluff were used in the evaluation of the site in Beaumont. Factors that were considered included proximity to deep water barge access, trucking distance to the disposal cavern, design of receiving facilities and casing/tubing configuration.

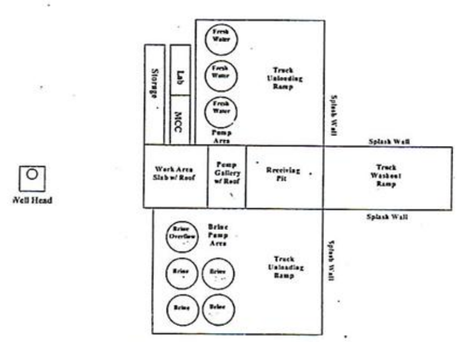
Experience at the Moss Bluff facility demonstrated the casing /tubing configuration at that facility was more than adequate to manage routine and greater than normal flow rates. Thus a casing /tubing configuration similar to or even slightly smaller would be satisfactory. More important to the siting question was the proximity to deep water and a minimal truck haul distance if any. Both of these latter conditions have been satisfied with respect to the Beaumont site. Deep water access is within 2 miles of the disposal cavern which provides for essentially uninterrupted barge movements to the dock and a deminimis trucking distance.

The last significant factor at the Beaumont site was the surface receiving facilities from the standpoint of whether worthwhile modifications could be made to the design and/or installation. A review of the initial Moss Bluff receiving facility indicated areas of improvement for efficiency purposes (functionally the original design was more than adequate). These areas of improvement included increased ramp area to allow more trucks to unload simultaneously from three sides instead of one side, a below surface pump gallery to provide a continuous submerged suction to the transfer pumps thus eliminating an intermediate submersible pump to lift the waste to the transfer pumps, higher volume “gun” lines to provide additional brine to the waste to reduce viscosity and augment resuspension of solids and repositioning of tanks and other equipment to streamline operations.

Although the distance of transfer from the receiving basin to the cavern wellhead at the Moss Bluff facility is 2600 feet and has caused no operational issues, it was felt that reducing any transfer distance would be beneficial from a power consumption standpoint. The receiving basin is anticipated to be within a 100 foot radius of the disposal cavern wellhead when construction is completed. Figure 5 is attached illustrating the general site layout of the surface facilities.

FIGURE 5 A

SURFACE RECEIVING FACILITY
GENERAL PLOT PLAN



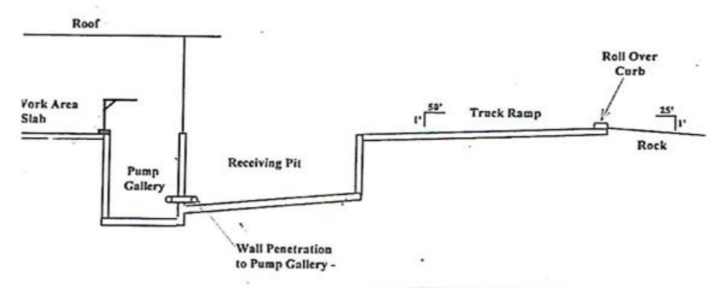


FIGURE 5 B

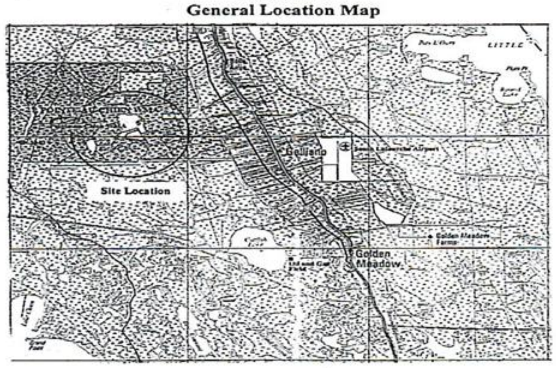
SURFACE RECEIVING FACILITY

NO SCALE

<u>Louisiana Area Cavern.</u> Ideally the most efficient site would be a site whereby a barge (or other vessel) could come to a receiving facility and unload directly to the disposal cavern. The Beaumont facility comes close to achieving the "ideal" location in as much as the cavern is close to the barge receiving dock. The Louisiana location from a technical standpoint meets almost all of the technical/operational requirements of an ideal site because of proximity to the disposal cavern, lack of rehandling, and/or other waste conditioning requirements. This site is located within the saltwater marsh environment of the southern portion of the state of Louisiana. These southern saltwater marshes have been and are still heavily explored for oil and gas resources. The exploration sites are generally accessed by means of canals dredged to the site. The disposal site is located in an area of existing large bayous and interconnecting dredged canals which provides direct access for the waste transport barges.

This site overlies the entire domal salt formation. Similar to the other two Texas sites, this dome has two existing caverns developed as brine wells in the 1960s and 1970s. The wells were plugged and abandoned per regulatory requirements and thus, no sonar survey information is available. Based on some drilling records, it estimated that several million barrels of capacity exists between the two caverns. New reentry wells will be drilled to access the caverns (after necessary operating permits have been obtained) using essentially the same casing/ tubing design previously used. See Figure 6 for general location illustration.

FIGURE 6
General Location Map



Since the location is in a marsh area with little dry ground for receiving basins and associated equipment, it was proposed to adopt and modify the relatively new method of Floating Production and Storage vessels (FPSOs) used by the oil and gas producing industry as a self contained receiving facility. Under this proposal, a large hopper or deck barge would be configured to have brine holding tanks, waste holding tanks, pump gallery and pumps, necessary pipe runs and connections, power generation equipment and some equipment storage. The deck would be designed to support a low pressure long stick crane in the event barges require solids removal not capable by pumping. Personnel quarters would be available on a much smaller separate barge. This approach has several advantages given the character of the site in that on site construction activity is minimized, extensive disturbance of the marsh environment is virtually eliminated, and the equipment can be removed by refloating the barge in the event of large hurricanes such as was experienced last year in this general vicinity. I should be noted that anecdotal evidence after the storm indicates that such a facility as described above would have been relatively unaffected by the storm. See Figure 7 for a schematic illustration of the proposed receiving barge.

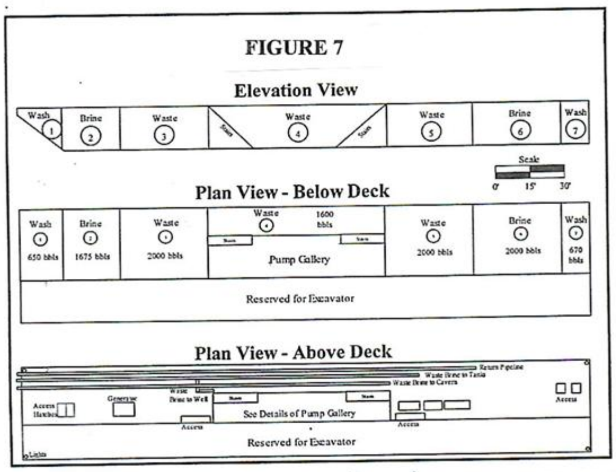


FIGURE 7

International Potential

As mentioned previously, the gulf coast can be considered to encompass the zone from the Yucatan Peninsula in Mexico to the Florida coast. Most of the coastline is in the US with the majority if it shared between Texas and Louisiana. The nature of the Gulf of Mexico (GOM) exploration and production mandates that the bulk of the waste come ashore in these two states and be managed within the states. Both states have specific regulatory programs and requirements for salt cavern disposal. See attachments 1 and 2 for copies of the Texas and Louisiana regulations.

Salt cavern disposal options are by no means restricted to the United States. There is every reason to expect examples of cavern usage for disposal even though there may be no formal regulatory program. Other jurisdictions do in fact have formal regulatory programs in place. Mexico, for instance, has a new formal regulation for the disposal of industrial wastes in caverns. Mexico does not exempt oil and gas wastes from their hazardous waste regulations although they do allow for the injection of oilfield wastes into a brine filled cavern. All other more traditional industrial sources (i.e. petrochemical plants, refineries etc) must be treated or immobilized and then placed into a dewatered cavern for ultimate disposal. See attachment 3 for a copy of the new Mexican regulation (Spanish version, English not available).

Mexico would appear to be a natural place to site a disposal facility. The country has an abundance of salt both near the coast Veracruz area) and in the interior (Monterey area).

The coastal salt domes are widely dispersed offering more than a single possible location. The interior deposits may be more suitable for industrial wastes.

Outside of the Gulf of Mexico region, the next oil and gas producing region that would seem to offer serious potential would be the North Sea region. The countries with the highest potential would first be the UK, then the Netherlands and then Denmark. This is based on the fact that these countries contain exploitable salt deposits and are proximate to oil and gas exploration activities in the North Sea. It does not mean that any of these countries have regulatory programs in place to provide for a project to be developed or even have policies that would encourage the development of a project. Based on some limited experience in the UK, it is known that the more recent EU Directives for waste are favorable for salt cavern disposal. As the case in Mexico, oil and gas wastes are likely to be classified as hazardous waste. A recent project in the Manchester region of the UK was granted authority to dispose of treated/solidified wastes in a dry mine. See attachment 4 for reference to the EU Directives.

Summary

The purpose of this paper was to provide a brief update on salt cavern waste disposal projects (oilfield wastes) that are either in operation or proposed for development. An additional purpose was to outline changes made from one project to the next that significantly improved operating efficiencies or cost effectiveness or both.

The original gulf coast high volume cavern was the Moss Bluff facility located between Houston and Beaumont. It is permitted to manage up 15,000 barrels per day of oilfield waste either as fluids, solids or in combination. The depth to the top of cavern is 1400+ feet bgs and had an initial sonared volume of 6.2 million barrels. The last cemented string is 10 ¾ inches and has two hanging strings of 8 5/8 and 5 ½ inches respectively. The site is located inland about 26 miles from the receiving dock. Discharge is into a 1500 barrel concrete basin using a submersible pump to transfer waste to the waste conveyance line and into the cavern.

The second proposed cavern is located in the Beaumont area which is closer to the majority of transfer locations which are the original aggregators of the waste from the drilling rigs. The site is within 2 miles of a deep water receiving dock which provides uninterrupted access for barges. The cavern is estimated to have similar or greater volumes than the Moss Bluff caver with the cavern roof over 2200 feet bgs. Since waste densities are greater than the brine in the cavern, greater depths to the roof do not have a large impact on pumping costs. The receiving basin will be concrete but smaller in volume and will have an underground pump gallery to provide for a continuous submerged suction for the transfer pumps. The basin will be only a short distance from the cavern wellhead in order to reduce transfer distances and line losses.

Finally, the second proposed project is in Louisiana which is in the midst of the majority of transfer stations that aggregate the wastes thus reducing primary barge transfer distances. The facility is located over a salt dome with the receiving facility being a reconfigured barge that is self contained. All equipment and process takes place on the vessel and then the waste is pumped directly to the cavern. The caverns are estimated to be several millions of barrels in capacity with cavern roofs comparable to the Beaumont area cavern. Casing/tubing configurations are similar to the other caverns described

The Gulf of Mexico is not the only area that can be developed for oilfield wastes. Projects are possible in Mexico and at other international locations including but not limited to selected EU countries.

ATTACHMENTS Available on the conference CD or from the internet

ATTACHMENT 1
Texas Railroad Commission Rule 8 and Rule 9

: Texas Administrative Code 8

<<Prev Rule **Texas Administrative Code** Next Rule>>

TITLE 16	ECONOMIC REGULATION
PART 1	RAILROAD COMMISSION OF TEXAS
CHAPTER 3	OIL AND GAS DIVISION
RULE §3.8	**Water Protection**

ATTACHMENT 2
Louisiana Rule 29- M -2
Title 43 NATURAL RESOURCES Part XVII. Office of Conservation

Injection and Mining Subpart 4. Statewide Order No. 29-M-2

Chapter 31. Disposal of Exploration and Production Waste in Solution-Mined Salt Caverns

§3101. Definitions

(no attachment 3)

ATTACHMENT 4

Mexico Rules for Salt Cavern Disposal (Spanish Version)

NORMA Oficial Mexicana NOM-145-SEMARNAT-2003, Confinamiento de residuos en cavidades construidas por disolución en domos salinos geológicamente estables.

Al margen un sello con el Escudo Nacional, que dice: Estados Unidos Mexicanos.- Secretaría de Medio Ambiente y Recursos Naturales.