2008 Storage Enhancement Project

June 3, 2008

EB-2008-0038 Technical Conference

Purpose

- Union Gas Limited is seeking approval to operate the Dow A, Oil Springs East, Payne and Enniskillen 28 storage pools above 0.7 psi/ft in accordance with the requirements of CSA Z341 and the regulations under the OGSRA.
- Seeking Vary Order From OEB to Waive Condition of Approval restricting to 0.70 psi/ft (15.8 kPa/m)

Proposed Changes

Pool	Incremental Pressure		Proposed PMOP	
	kPa	psi	kPaa	psia
Dow A	380	55	10,690	1,550
Enniskillen 28	230	33	8,730	1,266
Oil Springs East	300	44	8,060	1,169
Payne	350	51	9,250	1,342

PMOP – Planned Maximum Operating Pressure

Conditions of Approval (Typical)

Union shall not operate the Enniskillen Pool above a pressure representing a pressure gradient of .7 psi per foot of depth without leave of the board. Union shall support any leave application with an engineering study and economic study showing that the greater pressures are safe and in the public interest.

Report of the Board - EBRM 95 Condition 3

Definitions

- **Discovery Pressure**

  Pressure in the reservoir at initial discovery (kPaa, psia)

- **Delta-Pressuring**

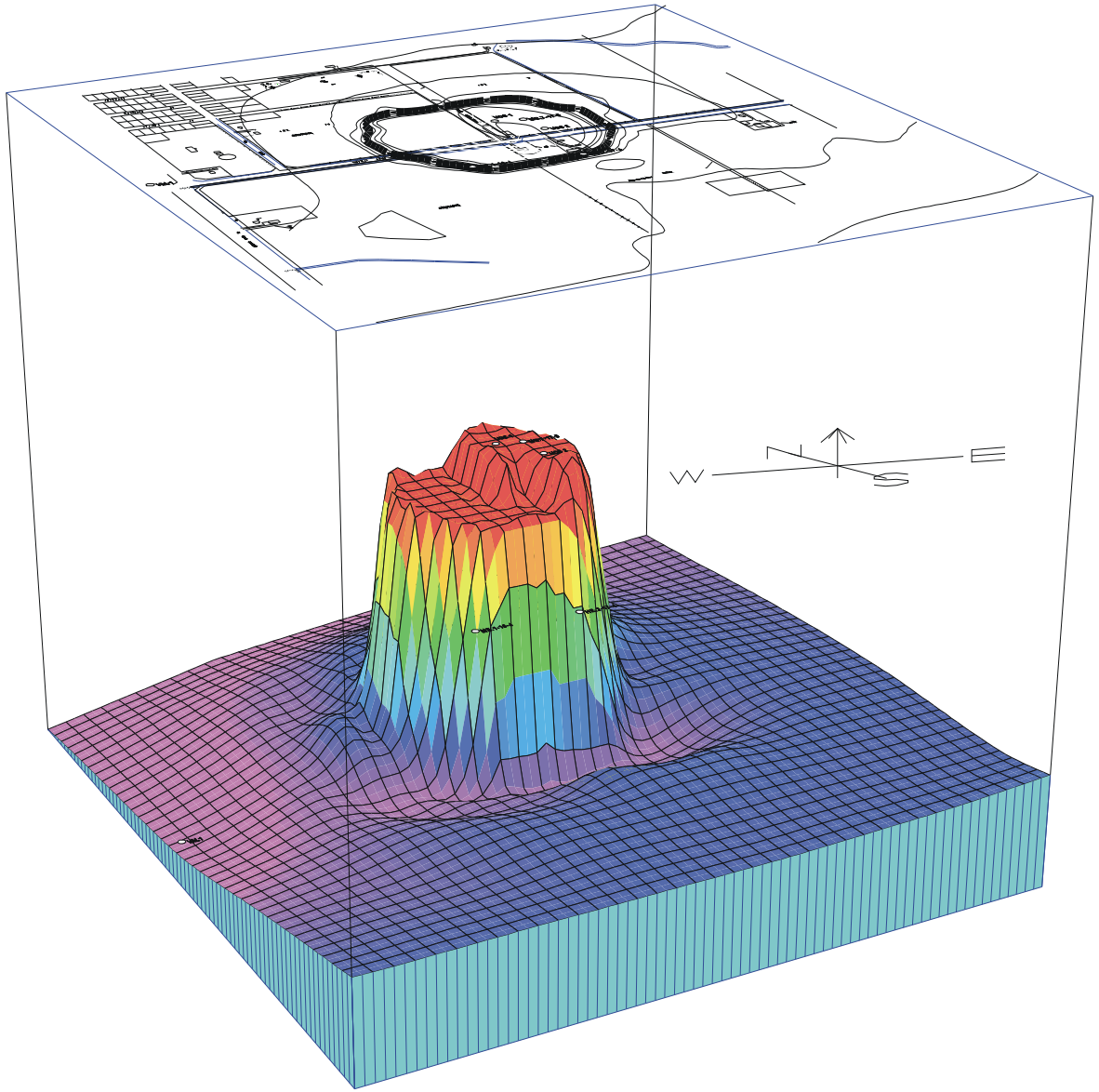
  Operating pressure above the discovery pressure (kPaa, psia)

- **Minimum Depth to Crest**

  Depth measured from ground elevation to the highest point on the reservoir (kPaa, psia)

- **Gradient**

  Pressure per unit of depth (psi/ft, kPa/m)



Delta Pressuring History

- All 20 of Union's pools are delta pressured
  - 14.70 kPa/m (0.65 psi/ft) pre -1986
  - 15.83 kPa/m (0.70 psi/ft) since 1986
  - 16.51 kPa/m (0.73 psi/ft) since 2001
- Michigan Public Service Commission and Federal Energy Regulatory Commission have approved pools at 0.73 psi/ft (16.51 kPa/m).

Background to Condition of Approval

- Prior to 1993 there were no standards governing the maximum operating pressure of a storage facility
- First version of CSA Z341 published in 1993 provided a national standard covering the maximum operating pressure of storage facilities
- In 1997 Ontario Regulation 245/97 – Provincial Operating Standards adopted CSA Z341
- For the 4 pools subject to this application there was no approved code/regulation in place when the 0.7 psi/ft conditions were imposed

CSA Z341 Code Requirements

7.6.2 Maximum operating pressure

The maximum operating pressure for the storage zone shall be

(a) the discovery pressure of the reservoir; or

(b) a higher pressure that has been shown by caprock testing (as specified in Clause 5.2) not to compromise the integrity of the storage zone. The maximum operating pressure shall not exceed 80% of the fracture pressure of the caprock formation. In the absence of local fracture pressure data, the maximum pressure shall be no greater than 18.1 kPa per metre of depth to the top of the reservoir.

7.6.3 Delta pressure

Where the maximum operating pressure of the storage zone is planned to be above the discovery pressure of the reservoir, the operator shall determine the impact on reservoir integrity of the planned maximum delta pressure prior to injecting hydrocarbons at pressures exceeding the discovery pressure of the reservoir.

5.2.3 Core analysis

The caprock core that is recovered shall be analyzed to determine

(a) threshold pressure;

(b) porosity; and

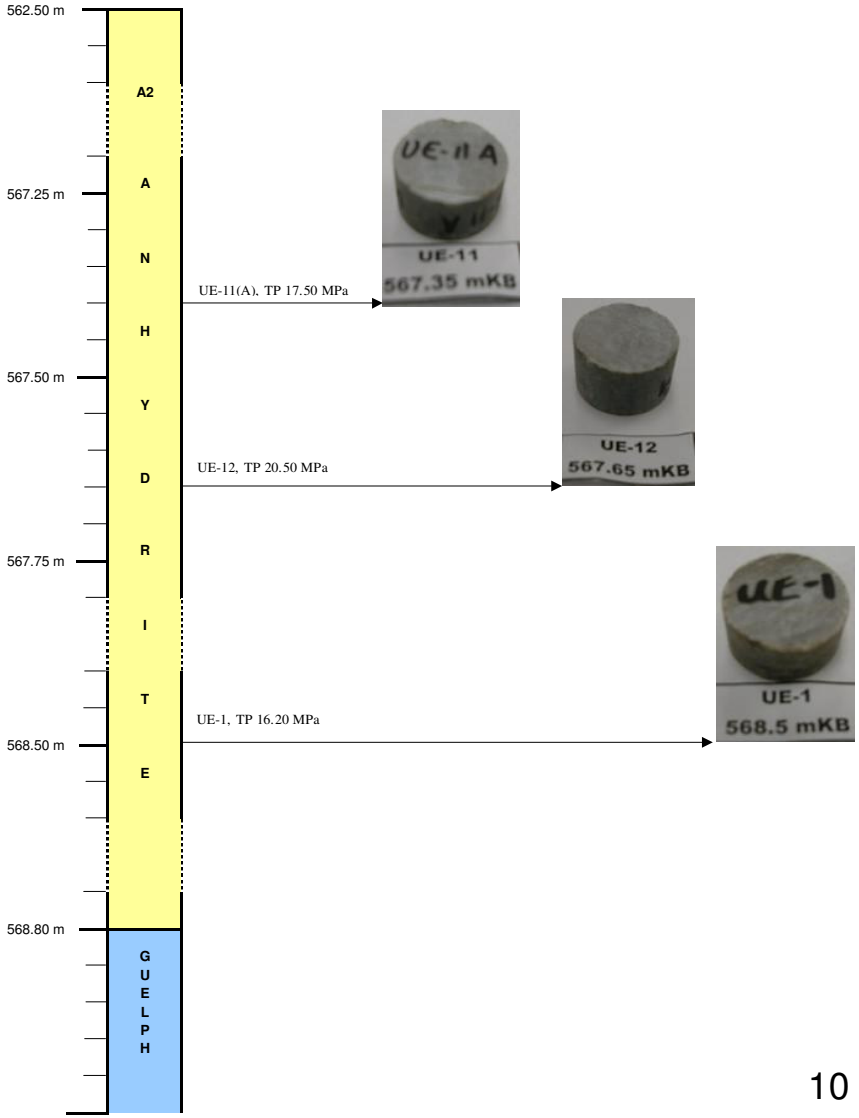
(c) permeability to air in the direction of maximum horizontal permeability, normal to the direction of maximum permeability, and in the vertical direction.

What Has Union Done?

- Collected caprock core samples from each of the 4 pools
- Threshold pressure testing
- Geomechanical testing
- In-situ caprock fracture testing
- Risk assessment – What-if Hazard/Operability Analysis
- Assessment of neighbouring activities report
- Well workovers at each pool

Caprock Core

- Sidewall core samples collected from each pool within the A2 Unit
- Samples sent to testing facility to complete threshold pressure and geomechanical testing



Core Testing

- Petrographic Analyses - Mineralogy, Texture, Grain Size, and Porosity
- Threshold pressure test – threshold pressure, porosity, permeability
- Confined tri-axial compression tests - Compressive Strength
- Brazilian tests - Tensile Strength
- Tri-axial compression test - Young's Modulus and Poisson's Ratio
- Series of confined tri-axial compression tests - Minimum Shear Strength

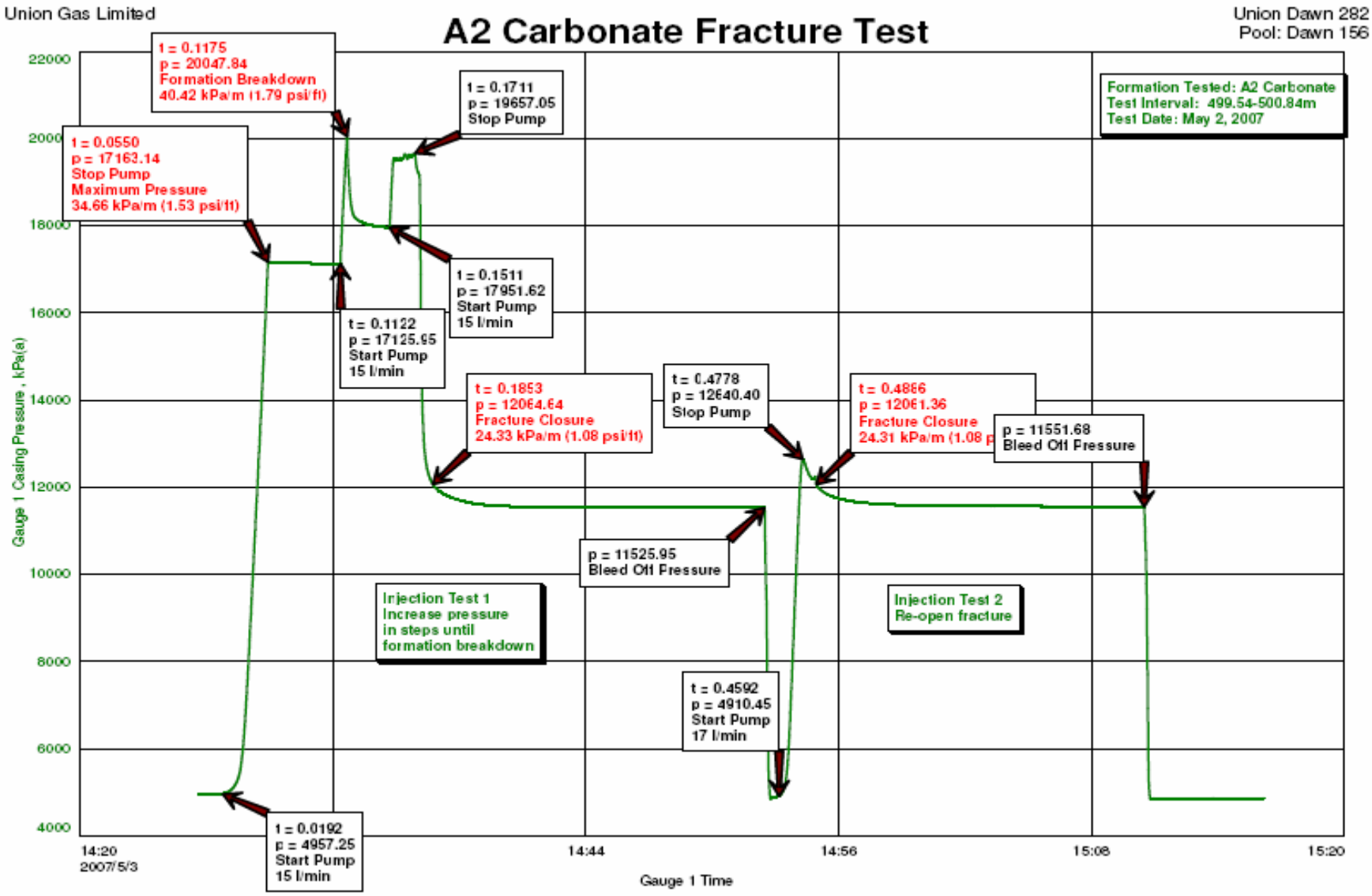
In-Situ Caprock Fracture Testing

- CSA Z341 Clause 7.6.2 :

  "The maximum operating pressure shall not exceed 80% of the fracture pressure of the caprock formation. In the absence of local fracture pressure data, the maximum pressure shall be no greater than 18.1 kPa per metre of depth to the top of the reservoir."

- To determine the local fracture gradient Union performed testing on new well in Dawn 156 Pool
- Isolated sections of caprock and performed a in-situ micro-fracture test
- Testing shows that the fracture gradient of the caprock formation is 24.33 kPa/m(1.08 psi/ft)
- Therefore, under section 7.6.2 of CSA Z341, the PMOP can be as high as 19.46 kPa/m (0.86 psi/ft).
- The proposed changes to the 4 pools would result in a gradient at PMOP of only 16.52 kPa/m (0.73 psi/ft)

Local Fracture Gradient Test Results



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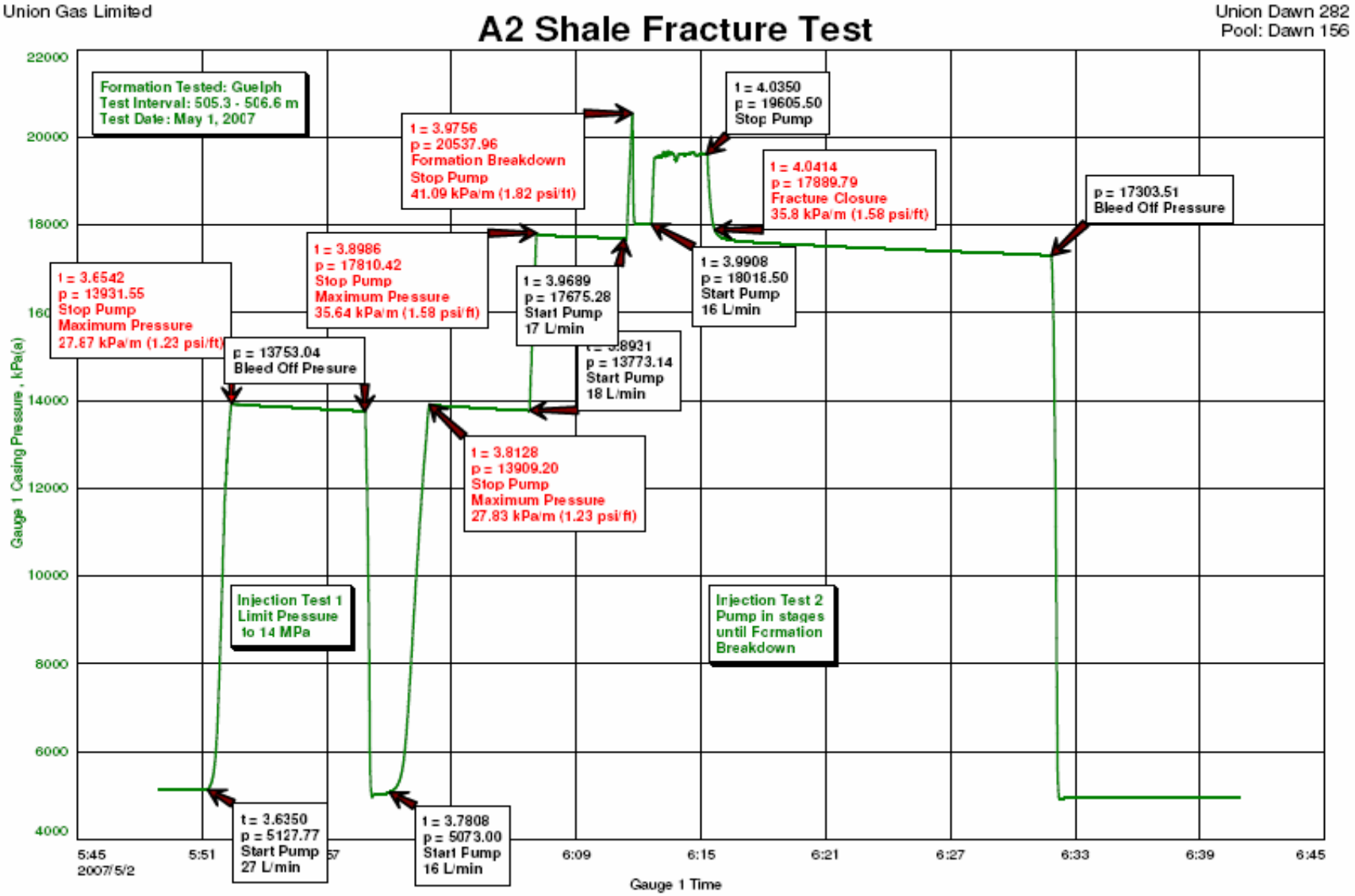
Regional Fracture Gradient Results



Pressure and Strength Summary

		IN SITU ROCK PRESSURE LIMITS							
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
Pool	Minimum Depth-to-Crest (m)	Compressive Strength (kPa)	Shear Strength (kPa)	Formation Breakdown Pressure (kPa)	Threshold Pressure (kPa)	Tensile Strength (kPa)	Fracture Closure Pressure (kPa)	Maximum Formation Operating Pressure (kPaa)	(kPaa WH)
Oil Springs E.	509.3	151,860	33,800	20,586	18,500	17,500	12,391	9,913	9,491
Enniskillen 28	554.1	117,000	33,900	22,397	20,500	19,688	13,481	10,785	10,280
Payne	589.4	141,800	30,960	23,824	20,500	20,946	14,340	11,472	10,896
Dow A	687.5	>110,950	>30,600	27,789	23,300	>21,513	16,727	13,382	12,590

1) Maximum Formation Operating Pressure = 80% (per CSA Z341) of Fracture Closure Pressure.
2) Fracture Closure Pressure is also referred to as Minimum In situ Stress.
3) Minimum Depth-to-Crest represents "Bottom-Hole".
4) All pressures are bottom-hole reservoir pressures except for column J which is a wellhead pressure.
5) Fracture Closure Pressure values are derived from applying the minimum gradient of 24.33 kPa/mas determined from the micro fracture testing completed in well UD.282.
6) Dow A strengths and threshold pressure derived from permeability, Young's Modulus, Poisson's Ratio,and grain density correlations with other four pools.

What-if Hazard / Operability Analysis

- Sessions completed September 18-19, December 19, 2007
  - Geologists, Engineers, Operations Superintendent, Risk Specialist and Scribe
- Reservoir Considerations
  - Geological Issues, Delta Pressuring Considerations, Existing or Abandoned Wells within 1 km, Operations within 5km
- Storage Operations
  - Crossover piping, Well and Reservoir, Compressor Station Influences
- Setting Plugs
  - Wireline operations, Two plug Maintenance, Cleanup, Other Considerations
- Development Workovers
  - Casing Milling, Replacement and Relining, Remedial Cementing, Wellhead Replacement
- Well Abandonments
  - Setting plugs, Cleanup, Other Considerations

Assessment of Neighbouring Activities

- Demonstrates compliance with section 7.2 of CSA Z341
- Review of existing and abandoned wells within 1 km
- Review of subsurface operations within 5 km
- Review wells penetrating the storage zone

Well Workovers

- New wellheads and master valves on all wells
- Casing and wellheads pressure tested to 12,075 kPa at surface

• Payne Pool – Abandoned 3 wells – Relined 6 wells	• Enniskillen 28 – Reline 1 well – Remedial cementing
• Oil Springs East – Relined 1 well	• Dow A – Remedial cementing

Consultation

- Met with MNR on November 22, 2007
- Provided Technical Information to MNR on Feb. 7, 2008
- Met with Landowners Winter 2007/08

Economics

- Space created by this project will be used for unregulated ex franchise storage
- NGEIR decision (EB-2005-0551) determined unregulated ex franchise storage projects would not be part of regulated utility
- Therefore Union believes it is not necessary to complete economic analysis for this project
- Capacity will be sold ex franchise
- Costs will be accounted for in ex franchise account

Lands and Environmental

- No significant concerns have been identified by landowners in the effected pools
- Concerns general in nature
  - Will there be additional restriction on my property, No
  - Will there be additional compensation, No
- No new pipeline facilities required
- No significant environmental impacts as a result of increasing pressure in pools

Summary

Union believes that this request is in the public interest and should be approved for the following reasons:

- There are no significant landowner or environmental concerns
- Project specific economics are not required in light of the NGEIR decision
- The pools will be operated as per the CSA code and Ontario Regulations
- Union has completed the required engineering and geological reports to show that the greater pressures are safe.