

## GCL COMPATIBILITY WITH AIRPORT DE-ICING FLUID

In the airline industry, de-icers are used to prevent ice, snow, and frost from accumulating on aircraft surfaces. Although there has been significant interest in creating a more benign de-icing system, chemicals such as glycol, in the form of ethylene glycol or propylene glycol, are still the most common de-icing fluids. Glycol-based de-icing fluids can leak into local stormwater runoff, potentially causing pollution. Any liner systems for containment of this runoff must be chemically compatible with glycol.

CETCO has performed compatibility testing of Bentomat ST with airport de-icing fluid (glycol diluted 50/50 with water). The industry standard for permeability testing with an organic leachate is to run a minimum of 2 pore volumes through the sample. After permeation of two pore volumes, the test results showed a hydraulic conductivity of  $7 \times 10^{-10}$  cm/sec at a confining pressure of 5 psi. This is less than CETCO's GCL specification for hydraulic conductivity of  $5 \times 10^{-9}$  cm/sec at 5 psi confining pressure.

CETCO would expect similar results for de-icing agents in the form of either propylene glycol or ethylene glycol. Thus, based upon this laboratory data, CETCO GCLs were found compatible with de-icing fluid (glycol diluted 50/50 with water).

Sample: Bentomat ST		Permeability equation : $((0.879 \times \text{Thickness}) / (2 \times \pi \times r^2 \times \text{Time})) \times \ln(\text{Change in Head})$															
Lot# 199908030 Roll# 1801																	
Project # : 98-261		-2		ABX Wetlands		Flux equation : $((\text{Inflow} + \text{Outflow}) / 200) / \pi \times r^2 / \text{Time}$											
Initial Thickness :		0.70		cm.		Hydration : 48hrs				Permeant :		Leachate w/ Ethylene Glycol					
Test Position :		302				Initial Head :		2psi 140.6 cm.		Analyst :		NP ate Printed :					
Cell Size :		4 in.				Max. Effective Stress :		5psi 34.5kPa		Requested by :		JO ate Begun : Di					
Final Thickness :		0.65		cm.		* indicates value meets Flux Ratio ASTM termination criteria											
Conversions : 1 psi = 2.307 feet of head 1 foot of head = 30.48 cm 1 psi = 70.32 cm												Flux (English) = Flux * Ssh = Flux * 9					
	Time	Reading		Reading		Head		H		Initial K		Initial Flux		Avg Flux		Final K	
Date	(min)	In	X	Out	Y	X-Y	(cm)	(cm)	(cm/sec)	(m³/m²/sec)			(m³/m²/sec)		(cm/sec)		
3/22/1999	0	0	0.0	24.0	24.0	0.0	24.0	140.63	164.63								
	72	72	0.4	23.6	24.0	0.0	23.6	140.63	164.23	2.14E-09	5.71E-09					1.98E-9	
	293	293	1.0	23.0	24.0	0.0	23.0	140.63	163.63	1.05E-09	2.79E-09					9.73E-10	
3/23/1999	1270	1270	3.4	20.6	22.9	1.1	19.5	140.63	160.13	1.40E-09	3.68E-09					1.30E-9	
	1582	1582	3.9	20.1	22.6	1.4	18.7	140.63	159.33	1.02E-09	2.64E-09					9.43E-10	
	1789	1789	4.1	19.9	22.4	1.6	18.3	140.63	158.93	7.68E-10	1.99E-09	*				7.13E-10	
3/24/1999	2715	2715	5.6	18.4	21.8	2.2	16.2	140.63	156.83	9.08E-10	2.33E-09	*				8.44E-10	
	3048	3048	5.9	18.1	21.4	2.6	15.5	140.63	156.13	8.50E-10	2.16E-09	*				7.89E-10	
3/25/1999	4149	4149	7.1	16.9	20.4	3.6	13.3	140.63	153.93	8.15E-10	2.05E-09	*				7.57E-10	
3/26/1999	5590	5590	8.7	15.3	19.5	4.5	10.8	140.63	151.43	7.19E-10	1.78E-09	*	2.00E-09			6.67E-10	
3/29/1999	0	5590	0.0	24.0	24.0	0.0	24.0	140.63	164.63								
	347	5937	0.1	23.9	23.6	0.4	23.5	140.63	164.13	5.54E-10	1.48E-09					5.15E-10	
3/30/1999	1407	6997	0.9	23.1	22.8	1.2	21.9	140.63	162.53	5.84E-10	1.55E-09	*				5.43E-10	
	1730	7320	1.0	23.0	22.2	1.8	21.2	140.63	161.83	8.45E-10	2.23E-09					7.85E-10	
	1902	7492	1.1	22.9	22.0	2.0	20.9	140.63	161.53	6.82E-10	1.79E-09	*				6.34E-10	
3/31/1999	2881	8471	2.3	21.7	21.5	2.5	19.2	140.63	159.83	6.83E-10	1.78E-09	*				6.35E-10	
	3016	8606	2.4	21.6	21.4	2.6	19.0	140.63	159.63	5.87E-10	1.52E-09	*				5.45E-10	
4/1/1999	4382	9972	3.6	20.4	20.2	3.8	16.6	140.63	157.23	7.01E-10	1.81E-09	*				6.51E-10	
	4674	10264	3.8	20.2	20.0	4.0	16.2	140.63	156.83	5.52E-10	1.41E-09	*				5.12E-10	
	4823	10413	3.9	20.1	19.9	4.1	16.0	140.63	156.63	5.42E-10	1.38E-09	*	1.53E-09			5.03E-10	
4/5/1999	0	10413	0.0	24.0	24.0	0.0	24.0	140.63	164.63								
	329	10742	0.3	23.7	23.7	0.3	23.4	140.63	164.03	7.02E-10	1.87E-09					6.52E-10	
4/6/1999	1397	11810	1.0	23.0	22.9	1.1	21.9	140.63	162.53	5.44E-10	1.44E-09	*				5.05E-10	
	1916	12329	1.5	22.5	22.4	1.6	20.9	140.63	161.53	7.52E-10	1.98E-09					6.98E-10	
4/7/1999	3354	13767	2.6	21.4	21.3	2.7	18.7	140.63	159.33	6.03E-10	1.57E-09	*				5.60E-10	
4/8/1999	4287	14700	3.5	20.5	20.5	3.5	17.0	140.63	157.63	7.27E-10	1.87E-09	*				6.75E-10	
4/9/1999	5717	16130	4.6	19.4	19.7	4.3	15.1	140.63	155.73	5.36E-10	1.37E-09		1.69E-09			4.98E-10	
4/12/1999	0	16130	0.0	24.0	24.0	0.0	24.0	140.63	164.63								
	494	16624	0.3	23.7	23.6	0.4	23.3	140.63	163.93	5.46E-10	1.46E-09					5.07E-10	

4/13/1999	1438	17568	1.2	22.8	22.9	1.1	21.7	140.63	162.33	6.57E-10	1.74E-09	*		6.10E-10
	1831	17961	1.5	22.5	22.6	1.4	21.1	140.63	161.73	5.96E-10	1.57E-09	*		5.53E-10
4/14/1999	2893	19023	2.4	21.6	21.8	2.2	19.4	140.63	160.03	6.29E-10	1.65E-09	*		5.84E-10
4/15/1999	4318	20448	3.6	20.4	20.6	3.4	17.0	140.63	157.63	6.71E-10	1.73E-09	*		6.23E-10
	4705	20835	3.9	20.1	20.3	3.7	16.4	140.63	157.03	6.23E-10	1.59E-09	*		5.79E-10
4/16/1999	5829	21959	4.8	19.2	19.5	4.5	14.7	140.63	155.33	6.12E-10	1.55E-09	*		5.69E-10
	5997	22127	4.9	19.1	19.4	4.6	14.5	140.63	155.13	4.85E-10	1.22E-09	*		4.50E-10
	6140	22270	5.0	19.0	19.3	4.7	14.3	140.63	154.93	5.71E-10	1.44E-09	*		5.30E-10
	6152	22282	5.1	18.9	19.2	4.8	14.1	140.63	154.73	6.81E-09	1.71E-08			6.32E-9
4/19/1999	10184	26314	8.1	15.9	16.5	7.5	8.4	140.63	149.03	5.89E-10	1.45E-09		6.67E-09	5.47E-10
4/20/1999	0	26314	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
	150	26464	0.2	23.8	23.8	0.2	23.6	140.63	164.23	1.03E-09	2.74E-09			9.52E-10
	525	26839	0.3	23.7	23.5	0.5	23.2	140.63	163.83	4.11E-10	1.10E-09			3.82E-10
4/22/1999	1443	27757	1.0	23.0	22.8	1.2	21.8	140.63	162.43	5.91E-10	1.57E-09			5.49E-10
	1738	28052	1.2	22.8	22.6	1.4	21.4	140.63	162.03	5.29E-10	1.39E-09	*		4.91E-10
	1987	28301	1.4	22.6	22.4	1.6	21.0	140.63	161.63	6.28E-10	1.65E-09	*		5.83E-10
4/23/1999	2880	29194	2.1	21.9	21.8	2.2	19.7	140.63	160.33	5.72E-10	1.50E-09	*	3.57E-09	5.31E-10
4/26/1999	0	29194	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
4/27/1999	1058	30252	1.2	22.8	23.2	0.8	22.0	140.63	162.63	7.31E-10	1.94E-09			6.78E-10
	1475	30669	1.6	22.4	22.8	1.2	21.2	140.63	161.83	7.48E-10	1.97E-09	*		6.94E-10
4/28/1999	2475	31669	2.8	21.2	22.0	2.0	19.2	140.63	159.83	7.86E-10	2.06E-09	*		7.30E-10
4/29/1999	3910	33104	3.7	20.3	20.8	3.2	17.1	140.63	157.73	5.83E-10	1.50E-09			5.41E-10
	4187	33381	3.9	20.1	20.6	3.4	16.7	140.63	157.33	5.80E-10	1.48E-09	*		5.38E-10
4/30/1999	5520	34714	5.1	18.9	19.5	4.5	14.4	140.63	155.03	6.99E-10	1.77E-09	*		6.49E-10
5/3/1999	0	34714	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
	294	35008	0.2	23.8	23.5	0.5	23.3	140.63	163.93	9.17E-10	2.45E-09			8.51E-10
5/4/1999	1433	36147	1.2	22.8	22.6	1.4	21.4	140.63	162.03	6.47E-10	1.71E-09			6.01E-10
	1539	36253	1.4	22.6	22.4	1.6	21.0	140.63	161.63	1.47E-09	3.88E-09			1.37E-9
5/5/1999	2800	37514	2.4	21.6	21.3	2.7	18.9	140.63	159.53	6.56E-10	1.71E-09			6.09E-10
	3086	37800	2.7	21.3	21.0	3.0	18.3	140.63	158.93	8.33E-10	2.16E-09			7.74E-10
5/7/1999	5782	40496	5.0	19.0	19.3	4.7	14.3	140.63	154.93	5.98E-10	1.53E-09			5.55E-10
	5968	40682	5.2	18.8	19.1	4.9	13.9	140.63	154.53	8.79E-10	2.21E-09			8.16E-10
5/10/1999	9988	44702	8.0	16.0	15.9	8.1	7.9	140.63	148.53	6.23E-10	1.53E-09			5.79E-10
	0	44702	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
5/11/1999	998	45700	1.0	23.0	23.5	0.5	22.5	140.63	163.13	5.80E-10	1.54E-09			5.39E-10
	1312	46014	1.3	22.7	22.9	1.1	21.6	140.63	162.23	1.11E-09	2.95E-09			1.03E-9
5/12/1999	2626	47328	2.1	21.9	21.9	2.1	19.8	140.63	160.43	5.37E-10	1.41E-09			4.99E-10
	2860	47562	2.3	21.7	21.7	2.3	19.4	140.63	160.03	6.75E-10	1.76E-09	*		6.27E-10
5/13/1999	3975	48677	3.1	20.9	21.0	3.0	17.9	140.63	158.53	5.34E-10	1.38E-09	*		4.96E-10
5/14/1999	5362	50064	4.1	19.9	19.7	4.3	15.6	140.63	156.23	6.66E-10	1.70E-09	*		6.19E-10
	5782	50484	4.4	19.6	19.4	4.6	15.0	140.63	155.63	5.79E-10	1.47E-09	*	1.77E-09	5.38E-10
5/18/1999	0	50484	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
	257	50741	0.3	23.7	23.8	0.2	23.5	140.63	164.13	7.49E-10	2.00E-09			6.95E-10
	390	50874	0.5	23.5	23.7	0.3	23.2	140.63	163.83	8.70E-10	2.32E-09	*		8.08E-10
5/19/1999	1376	51860	1.3	22.7	22.8	1.2	21.5	140.63	162.13	6.69E-10	1.77E-09	*		6.21E-10

	1507	51991	1.4	22.6	22.7	1.3	21.3	140.63	161.93	5.96E-10	1.57E-09	*		5.53E-10
5/20/1999	2810	53294	2.5	21.5	21.6	2.4	19.1	140.63	159.73	6.64E-10	1.74E-09	*		6.17E-10
	2984	53468	2.7	21.3	21.4	2.6	18.7	140.63	159.33	9.11E-10	2.36E-09			8.46E-10
5/21/1999	4260	54744	3.7	20.3	20.3	3.7	16.6	140.63	157.23	6.58E-10	1.69E-09			6.11E-10
	4730	55214	4.0	20.0	19.7	4.3	15.7	140.63	156.33	7.72E-10	1.97E-09	*		7.17E-10
5/24/1999	0	55214	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
	298	55512	0.2	23.8	23.8	0.2	23.6	140.63	164.23	5.16E-10	1.38E-09			4.79E-10
5/25/1999	1449	56663	1.1	22.9	22.7	1.3	21.6	140.63	162.23	6.73E-10	1.79E-09			6.25E-10
	1637	56851	1.3	22.7	22.5	1.5	21.2	140.63	161.83	8.30E-10	2.19E-09	*		7.71E-10
	1796	57010	1.4	22.6	22.4	1.6	21.0	140.63	161.63	4.92E-10	1.29E-09			4.57E-10
5/26/1999	2950	58164	2.3	21.7	21.4	2.6	19.1	140.63	159.73	6.48E-10	1.69E-09			6.02E-10
	3397	58611	2.5	21.5	20.8	3.2	18.3	140.63	158.93	7.10E-10	1.84E-09	*		6.60E-10
5/27/1999	4335	59549	3.4	20.6	20.1	3.9	16.7	140.63	157.33	6.82E-10	1.75E-09	*		6.33E-10
5/28/1999	5775	60989	4.6	19.4	18.9	5.1	14.3	140.63	154.93	6.75E-10	1.71E-09	*		6.27E-10
	5999	61213	4.7	19.3	18.2	5.8	13.5	140.63	154.13	1.46E-09	3.67E-09		1.91E-09	1.36E-9
6/1/1999	0	61213	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
6/2/1999	1066	62279	1.1	22.9	23.2	0.8	22.1	140.63	162.73	6.89E-10	1.83E-09			6.39E-10
	1166	62379	1.2	22.8	23.1	0.9	21.9	140.63	162.53	7.78E-10	2.06E-09	*		7.22E-10
6/3/1999	2754	63967	2.3	21.7	21.8	2.2	19.5	140.63	160.13	5.92E-10	1.55E-09	*		5.50E-10
6/4/1999	4233	65446	3.2	20.8	20.5	3.5	17.3	140.63	157.93	5.92E-10	1.53E-09	*		5.49E-10
6/7/1999	0	65446	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
	109	65555	0.1	23.9	23.9	0.1	23.8	140.63	164.43	7.05E-10	1.89E-09			6.55E-10
6/8/1999	1349	66795	1.4	22.6	22.8	1.2	21.4	140.63	162.03	7.50E-10	1.99E-09	*		6.96E-10
	1550	66996	1.5	22.5	22.2	1.8	20.7	140.63	161.33	1.36E-09	3.58E-09			1.26E-9
6/9/1999	2807	68253	2.7	21.3	21.7	2.3	19.0	140.63	159.63	5.33E-10	1.39E-09			4.95E-10
	3240	68686	3.2	20.8	21.0	3.0	17.8	140.63	158.43	1.10E-09	2.85E-09			1.02E-9
6/11/1999	5790	71236	5.6	18.4	19.3	4.7	13.7	140.63	154.33	6.50E-10	1.65E-09			6.04E-10
6/14/1999	0	71236	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
6/15/1999	1214	72450	1.0	23.0	23.1	0.9	22.1	140.63	162.73	6.05E-10	1.61E-09			5.62E-10
6/16/1999	2648	73884	3.4	20.6	21.0	3.0	17.6	140.63	158.23	1.24E-09	3.23E-09			1.15E-9
	2773	74009	3.5	20.5	20.9	3.1	17.4	140.63	158.03	6.40E-10	1.64E-09			5.94E-10
6/17/1999	4176	75412	4.3	19.7	20.0	4.0	15.7	140.63	156.33	4.88E-10	1.25E-09	*		4.53E-10
6/18/1999	5511	76747	5.1	18.9	19.0	5.0	13.9	140.63	154.53	5.49E-10	1.39E-09	*		5.09E-10
	5754	76990	5.3	18.7	18.8	5.2	13.5	140.63	154.13	6.75E-10	1.69E-09	*		6.26E-10
	5958	77194	5.4	18.6	18.6	5.4	13.2	140.63	153.83	6.04E-10	1.51E-09	*		5.61E-10
6/20/1999	8487	79723	7.1	16.9	16.9	7.1	9.8	140.63	150.43	5.59E-10	1.38E-09	*	1.82E-09	5.19E-10
6/25/1999	0	79723	0.0	24.0	24.0	0.0	24.0	140.63	164.63					
	1024	80747	0.9	23.1	23.4	0.6	22.5	140.63	163.13	5.65E-10	1.51E-09			5.25E-10
	1320	81043	1.2	22.8	22.9	1.1	21.7	140.63	162.33	1.05E-09	2.78E-09			9.75E-10
6/26/1999	2699	82422	2.5	21.5	21.9	2.1	19.4	140.63	160.03	6.54E-10	1.71E-09			6.08E-10
6/27/1999	4030	83753	3.5	20.5	20.9	3.1	17.4	140.63	158.03	5.98E-10	1.54E-09	*		5.55E-10
6/28/1999	5336	85059	4.5	19.5	20.0	4.0	15.5	140.63	156.13	5.86E-10	1.50E-09	*		5.44E-10
	5743	85466	5.0	19.0	19.4	4.6	14.4	140.63	155.03	1.10E-09	2.78E-09			1.02E-9
6/29/1999	6763	86486	6.6	17.4	19.3	4.7	12.7	140.63	153.33	6.84E-10	1.71E-09			6.35E-10
7/6/1999	0	86486	0.0	24.0	24.0	0.0	24.0	140.63	164.63					

	248	86734	0.3	23.7	23.5	0.5	23.2	140.63	163.83	1.24E-09	3.32E-09			1.15E-9
7/7/1999	1351	87837	1.8	22.2	22.7	1.3	20.9	140.63	161.53	8.11E-10	2.14E-09			7.53E-10
7/8/1999	3262	89748	3.0	21.0	20.6	3.4	17.6	140.63	158.23	6.83E-10	1.77E-09	*		6.34E-10
7/9/1999	4560	91046	4.3	19.7	19.4	4.6	15.1	140.63	155.73	7.76E-10	1.98E-09	*		7.21E-10
7/10/1999	5822	92308	5.9	18.1	18.5	5.5	12.6	140.63	153.23	8.11E-10	2.04E-09	*	<b>1.93E-09</b>	7.53E-10
									<b>Final Flux</b>	<b>1.9E-9</b>	<b>m<sup>3</sup>/m<sup>2</sup>/sec</b>			
									<b>Final Hydraulic Conductivity</b>		<b>7.0E-10</b>	<b>cm/s</b>		