PRECIDIUM™

150D-FR High-Performance Secondary Containment

'Passes with Distinction'

Meet the National Fire Code in your Diluted Bitumen Storage

This unique spray-applied system is the only liner material tested to the CAN/ULC-S668 Standard for Secondary Containment of Hydrocarbons up to 150°C.

QUANTUM Chemical

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BROCHURE

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All on-site photos used in this document were provided courtesy of Western Engineered Containment (WEC).

INTRODUCING

PRECIDIUM™ 150D-FR

PRECIDIUM™ 150D-FR, which is a unique two-component spray-applied system, differs from common polyureas in formulation and final polymer structure.

PRECIDIUM™ 150D-FR is designed to produce a highly cross-linked polymer matrix, with advanced fire retardant properties. This allows a unique combination of properties:

- meets the challenging set of properties required by the CAN/ULC-S668 Standard for the Secondary Containment of Aboveground Flammable and Combustible Liquid Tanks;
- can contain very high temperature chemicals, hydrocarbons and diluents up to 150°C in the event of a spill.

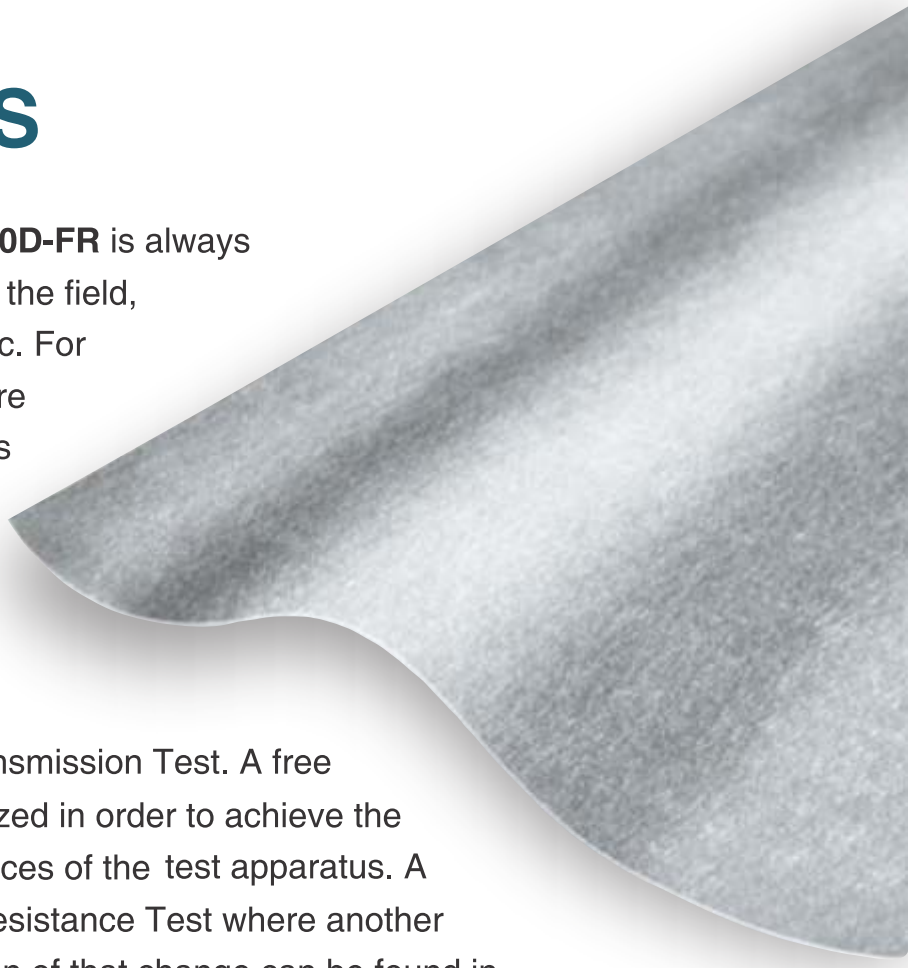
These performance properties are combined with the installation advantages of a spray-applied system, adhering to substrates such as concrete and steel.

PRECIDIUM™ 150D-FR can also be robotically-applied to geotextile fabric to provide a composite geomembrane and cover containments made of soil.

PRECIDIUM™ 150D-FR was developed by Quantum Chemical and with our network of expert certified installers, can provide the solution to your complex containment applications.

TEST SAMPLE

SPECIFICATIONS



Sample Preparation: **PRECIDIUM™ 150D-FR** is always sprayed on a substrate when installed in the field, usually concrete, steel or geotextile fabric. For the purposes of this testing, samples were prepared on Typar® 3401 Geotextile. This is the only substrate which facilitates the required testing, and represents the most common substrate used in secondary containment.

An exception to this was the Vapour Transmission Test. A free film of **PRECIDIUM™ 150D-FR** was utilized in order to achieve the best seal possible to both clamping surfaces of the test apparatus. A second exception was the Cold Crack Resistance Test where another geotextile fabric was used. An explanation of that change can be found in the discussion below in the body of the properties section.

The published tensile strength of Typar® 3401 Geotextile is 578N (ASTM D751, Grab Method) which is about 60% of the strength of the **PRECIDIUM™ 150D-FR** coating. For the purposes of the CAN/ULC-S668 testing, the samples prepared on a Typar® substrate were considered by Quantum to be non-reinforced. This conclusion was reached as we feel a reinforced geomembrane as referenced in the S668 Standard was intended to mean a geomembrane which contains a support structure stronger than the coating. Seam strengths are given in these material properties. In many applications the **PRECIDIUM™ 150D-FR** is sprayed directly into a containment structure and hence has no seams. With the introduction of robotically-sprayed panels on a geotextile fabric, the joining of the panels in the field became common. This joining is done with the same **PRECIDIUM™ 150D-FR** polymer, according to strict procedures for surface preparation, and yields consistent results for seam integrity. Quantum Chemical can be contacted for the Standard Operating Procedure for joining pre-sprayed panels.

TEST STANDARD REQUIREMENTS

CAN/ULC-S668

Material Strength Test: ASTM D751 Grab Method

30-40 mil **PRECIDIUM™ 150D-FR** on Typar® 3401

PRECIDIUM™ 150D-FR	CAN/ULC-S668 Requirement
1000 N	500 N

Vapour Transmission Test: ASTM D814

30-40 mil **PRECIDIUM™ 150D-FR** on Typar® 3401

Chemical	PRECIDIUM™ 150D-FR ($g/m^2/hr$)	CAN/ULC-S668 Requirement ($g/m^2/hr$)
IRM 903[1] (Diesel Fuel Equivalent)	0	Maximum 20
ASTM Fuel C[2] (Gasoline Equivalent with 50% BTEX)	18.9	Maximum 20
ASTM Fuel H[3] (Ethanol Blended Gasoline Equivalent with 50% BTEX)	17.6	Maximum 20
Methanol	16.7	Maximum 20
Ethanol	11.1	Maximum 20

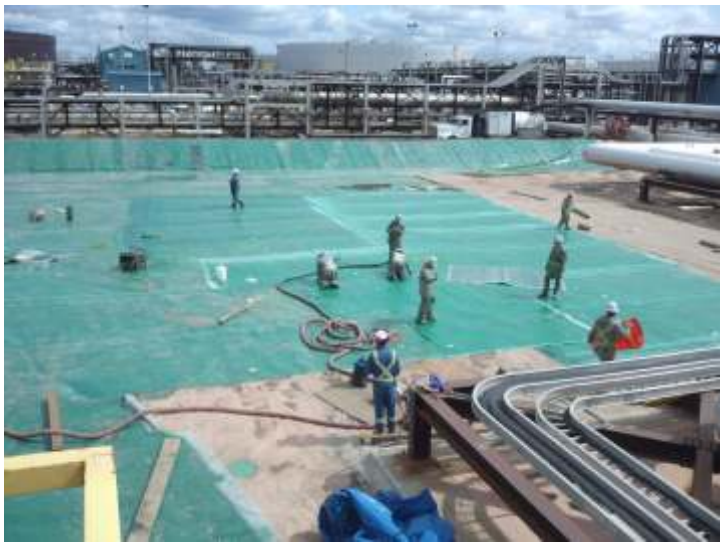
[1] Common Test Oil
[2] 50% Isooctane and 50% Toluene
[3] ASTM Fuel C with 15% Ethanol

Compatibility Test: ASTM D5322 30-Day Immersion

30-40 mil **PRECIDIUM™ 150D-FR** on Typar® 3401

Chemical	PRECIDIUM™ 150D-FR Weight Change	PRECIDIUM™ 150D-FR Volume Change[4]	PRECIDIUM™ 150D-FR Strength Retained
CAN/ULC-S668 Requirement	**(Maximum +/-10%)**	**(Maximum 20%)**	**(Minimum 50%)**
IRM 903[1] (Diesel Fuel Equivalent)	0%	Pass	112%
ASTM Fuel C[2] (Gasoline Equivalent with 50% BTEX)	+0.28%	Pass	80%
ASTM Fuel H[3] (Ethanol Blended Gasoline Equivalent with 50% BTEX)	-6.6%	Pass	83%
Methanol	-9.0%	Pass	94%
Ethanol	+0.3%	Pass	126%
Sodium Carbonate/ Bicarbonate pH 10	+3.4%	Pass	89.5%
NaCl[5]	+0.5%	Pass	98%
Sulphuric Acid Dilute pH 3	+3.10%	Pass	110%

[1] Common Test Oil
[2] 50% Isooctane and 50% Toluene
[3] ASTM Fuel C with 15% Ethanol
[4] It is difficult to determine the exact volume change as the thickness varies across the sample.
[5] Saturated NaCl solution in water at 20°C



Flammability Test: CAN/ULC-S668

30-40 mil on **PRECIDIUM™ 150D-FR** on Typar® 3401

Test Method	PRECIDIUM™ 150D-FR	CAN/ULC-S668 Requirement
CAN/ULC-S668 Custom Test	1 Second to Self-Extinguish	Max. 5 Seconds to Self-Extinguish

Seam Strength Test: ASTM D751 and ASTM D6392

Sample	Test	PRECIDIUM™ 150D-FR Seam	CAN/ULC-S668 Requirement
40 mil Robotically-Sprayed Panels Seamed with **PRECIDIUM™ 150D-FR**	**ASTM D751** Grab Tensile Shear Strength	1461 N	500 N
40 mil Robotically-Sprayed Panels Seamed with **PRECIDIUM™ 150D-FR**	**ASTM D6392** Seam Peel Test	4.3 N/mm	2.5 N/mm

Burst Strength Test: ASTM D751

60-70 mil **PRECIDIUM™ 150D-FR** on Typar® 3401

Test Method	PRECIDIUM™ 150D-FR	CAN/ULC-S668
ASTM D751: Hydrostatic Resistance Procedure A (Mullen)	Greater than 2,264 kPa	690 kPa

Tear Strength Test: ASTM D4533

30-40 mil **PRECIDIUM™ 150D-FR** on Typar® 3401

Test Method	PRECIDIUM™ 150D-FR	CAN/ULC-S668 Requirement
ASTM D4533[1]	105% Tear Strength Retained	Retain at least 90% Tear Strength

[1] Samples were tested before and after a 30-day immersion in ASTM Fuel C (50% Isooctane/50% Toluene)

Soil Burial Test: ASTM G160

Sample	PRECIDIUM™ 150D-FR	CAN/ULC-S668 Requirement
30-40 mil **PRECIDIUM™ 150D-FR** on Typar® 3401	• No Cracking • 127% Tensile Strength Retained	• No Cracking • Retain at least 70% Tensile Strength
50-60 mil **PRECIDIUM™ 150D-FR** on Typar® 3401	• No Cracking • 114% Tensile Strength Retained	• No Cracking • Retain at least 70% Tensile Strength

Accelerated Weather Test: ASTM D7238 as per CAN/ULC-S668

Sample	PRECIDIUM™ 150D-FR 3000-Hour Exposure	CAN/ULC-S668 Requirement[1]
30-40 mil **PRECIDIUM™ 150D-FR** on Typar® 3401	• No Cracking • 108% Tensile Strength Retained	• No Cracking • Retain at Least 70% Tensile Strength
50-60 mil **PRECIDIUM™ 150D-FR** on Typar® 3401	• No Cracking • 90% Tensile Strength Retained	• No Cracking • Retain at Least 70% Tensile Strength

[1] In this case UVB Bulbs were used instead of the prescribed UVA Bulbs, providing a more rigorous test as the UVB Bulbs provide a more destructive UV exposure.

Cold Temperature Crack Resistance Test: ASTM D751

30-40 mil **PRECIDIUM™ 150D-FR** on 8 oz Non-woven Geotextile[1]

Test Method	PRECIDIUM™ 150D-FR	CAN/ULC-S668 Requirement
ASTM D751 Modified as per CAN/ULC-S668	Pass	No Cracking at -40°C and +40°C

[1] In order to pass this requirement at -40°C, additional cushioning was required in the 180 degree fold. This cushioning is provided by the 8 oz. non-woven geotextile which is thicker than Typar 3401. Cold Temperature Crack Resistance is an important performance property, but a 180 degree fold is not encountered in most applications. If this condition is anticipated, it can be prepared for by using the 8 oz. non-woven geotextile.

Heat Aging Test: ASTM D751

40-50 mil **PRECIDIUM™ 150D-FR** on Typar® 3401

Test Method	PRECIDIUM™ 150D-FR	CAN/ULC-S668 Requirement[1]
ASTM D751 (Conditions used 60 Days at 80°C)	170% Tensile Strength Retained	Retain at least 50% Tensile Strength

PRECIDIUM™ 150D-FR High-Temperature (140°C) Hydrocarbon Immersion Results

Conditions: Samples were sealed in a bomb calorimeter filled with diluted bitumen from a major Canadian Oil Sands Producer. The calorimeter was heated to 140°C for 8 hours. The calorimeter was removed from the oven and allowed to cool for 16 hours; 50% of the samples were removed at this point. The remaining samples were left immersed in the diluted bitumen for 6 more days at ambient temperature.

The two immersion conditions were meant to recreate the effect of a major high temperature spill, which would remain hot for a period and then cool down, with the spill cleaned up within 7 days.

[1]During the heated portion of the test the pressure inside the sealed vessel rose to an undetermined level. While the pressure increase was not measured it is expected to be significant due to the high vapour pressure of diluent solvent. As a result the immersion conditions were more destructive than that which would be expected during a spill.

Results

Sample Type	Immersion Period[1]	Weight Change	Volume Change	Absolute Tensile Strength ASTM D412 (lbf)	Thickness Adjusted Tensile Strength ASTM D412 (psi)[2]	Elongation at Break ASTM D412 (%)	Tear Strength ASTM D624 (ppi)
150D-FR Free Film (nominal 100 mil)	140°C 8 hr. 20°C 16 hr.	+9%	+20%	-16%	-27%	-5%	-26%
150D-FR Free Film (nominal 100 mil)	140°C 8 hr. 20°C 160 hr.	+9%	+15%	-28%	-34%	+0%	-22%
150D-FR/Typar® Composite (nominal 70 mil)	140°C 8 hr. 20°C 16 hr.	+8%	+3%	-10%	-20%	+0%	-45%
150D-FR/Typar® Composite (nominal 70 mil)	140°C 8 hr. 20°C 160 hr.	+11%	+18%	-17%	-28%	+0%	-36%

[1] During the heated portion of the test the pressure inside the sealed vessel rose to an undetermined level. While the pressure increase was not measured it is expected to be significant due to the high vapour pressure of the diluent solvent. As a result, the immersion conditions were more destructive than that which would be expected during a spill.
[2] The tensile strength loss in psi is effected by the swelling of the material during the immersion, leading to a higher value.

Conclusion: According to the CAN/ULC-S668 Standard a geomembrane material is considered to have passed the chemical compatibility test if the weight change is no greater and 10%, the volume change is no greater than 20%, and the change in tensile strength is no greater than 50%. Under the challenging conditions of extremely high temperatures, **PRECIDIUM™ 150D-FR** met all these criteria, with the exception of the composite 7-day test which slightly missed the weight gain mark.

A loss in tensile and tear strength was seen after the initial 140°C immersion. The material properties did not change significantly after the initial high temperature exposure. This confirms that following the cool down period of a major spill, **PRECIDIUM™ 150D-FR** will provide effective containment for an extended period, allowing clean up to be completed.

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