SPRAY FOAM AND PEX TUBING

Dispelling Compatibility Myths with Laboratory Testing

Mike Richmond
Vice-President, Building Science and Compliance
Genyk Polyurethanes

Executive Summary

A commonplace situation in the construction industry is to project failure of a particular material without adequate testing. That is certainly the case with the relationship between PEX tubing and spray foam insulation. Genyk has undertaken laboratory testing that builds on the 2008 SPFA testing confirming the compatibility of spray foam and cPVC.[i]
Spray foam materials have been successfully installed with all types of plastic tubing.

The results of the Genyk laboratory testing confirms that the compatibility of PEX tubing and Genyk closed and open-cell spray foam materials is undeniable.

Testing done that exceeds normative spray foam installation protocols was done to simulate worst case scenarios. In every condition, Genyk spray foam did not weaken or deform the PEX tubing.

The Situation

Cross-linked polyethylene (PEX), a type of flexible plastic, is a popular replacement for traditional copper and galvanized steel water supply lines. Introduced to the North American market in the 1980s, PEX was originally targeted for the radiant floor market. Today, not only is PEX the standard choice for radiant heating, the material is currently used in more than sixty percent of new construction residential water supply systems.[ii]

Both medium and light-density spray foam products are regularly installed in direct contact with PEX. Genyk Polyurethanes manufactures two products that are consistently used in conjunction with PEX – *Boreal Elite*, a medium-density, closed-cell spray foam, and *Floraseal*, a light-density, material. To address misconceptions about the compatibility of PEX and Genyk materials, the laboratory research undertaken by Genyk is directed toward the following specific misconceptions:

- ✓ Spray foam products will adversely affect PEX connections
- ✓ The heat created by spray foam will melt and/or distort the PEX
- ✓ PEX piping under pressure at the time of spray foam application will split with additional pressure

The testing procedures described in this paper were carried out with the intent of addressing the potential for PEX and spray foam failure. This study is intended to provide end-users and design professionals with the information necessary to make informed decisions.

The Testing Process

The field application that best represents the 'worst scenario' conditions is that of a heated floor above an unheated area below (garage ceiling, cantilever, crawl space ceiling, etc.). Typically, the required thickness in these applications are five inches of *Boreal Elite* or nine inches of *Floraseal*. This situation informed the testing procedure.

Two 4'x8' samples with three separate 7.5" cavities were produced – one for *Boreal Elite* and an identical sample for the *Floraseal* material. In all six cavities, ½" PEX was installed the full eight-foot length. Each eight-foot section of PEX, in each test cavity, included a connection at the four-foot position. The PEX was capped at one end and hooked to a pressure gauge at the other.

The three PEX failure scenarios that informed the testing were deemed to be –

1. **Melting of PEX**
   Boreal Elite and *Floraseal* require heat to successfully complete the foaming process. This includes heat generated by the installation equipment and the exotherm created by the chemical reaction. In each cavity, temperatures were monitored for twenty-four hours (full cure). Temperature readings of the spray foam materials were taken immediately after spraying (maximum exotherm), one hour after spraying and twenty-four hours after spraying.
   The PEX in every cavity was inspected for any indication of PEX tubing and PEX connection deformation caused by excessive temperatures.
2. **Splitting of PEX**
   To eliminate the potential of PEX splitting because of pressure created during the spray process, two samples of each *Boreal Elite* and *Floraseal* were monitored to measure any additional pressure created during the foam process. One cavity was left unpressurized as a control test. Pressure in the 'pressurized' cavities were set at 80psi before spraying and readings were taken immediately after spraying, one hour after spraying and twenty-four hours after spraying.
   The PEX in every cavity was inspected for any indication of compromised PEX where the tubing would show splits or holes.
3. **Deformation of PEX**
   With both *Boreal Elite* and *Floraseal*, one cavity was left unpressurized. This was done to simulate the most common state of the PEX in the field. At the same time, the thicknesses of the spray foam materials were done at worst case scenarios – thicknesses beyond CAN/ULC Installation Standards. Depths that would create the most heat and pressure on the PEX.
   The PEX in every cavity was inspected for any indication of PEX tubing deviated from the installed specifications.

'Boreal Elite' test cavities

PEX connection

Measured PEX pressure

Genyk Polyurethane
1701 3rd Avenue, Shawinigan, Canada G9T 2W6
genyk.com | info@genyk.com

The three *Boreal Elite* test cavities were assembled to simulate actual site conditions.

CAVITY A – BEST PRACTICE INSTALLATION

PEX line located ½" from the substrate with connection at the horizontal and vertical mid-point of the cavity. This assembly represents PEX best practice installation.
The PEX line was set at a pre-spray setting of 80psi to simulate field test conditions.
Spray foam process done in accordance with the CAN/ULC S705.2 Installation Standard – three 2" passes with enough time for the *Boreal Elite* to cool to temperatures less than 37.8˚C (100˚F).

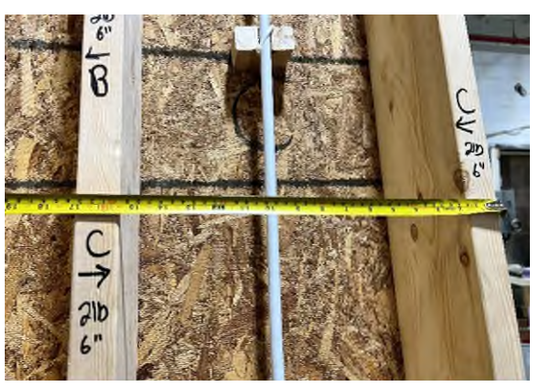
CAVITY B – OUTSIDE ACCEPTED INSTALLATION STANDARD

PEX line located 2.5" from the substrate with connection at the horizontal and vertical mid-point of the cavity. This assembly has the PEX placed in a location that is not considered ideal.
The PEX line was set at a pre-spray setting of 80psi to simulate field test conditions.
Spray foam process is done outside the CAN/ULC S705.2 Installation Standard – one 6" pass. This application represents an application that would typically result in a foam failure because of excessive exothermic temperatures. The intent of the 'worst case' sample was to create the maximum exothermic temperature in conjunction with pressure and project a 'failure' of the PEX under extreme conditions.

CAVITY C – WORST CASE SCENARIO

PEX line located 2.5" from the substrate with connection at the horizontal and vertical mid-point of the cavity. This assembly has the PEX placed in a location that is not considered ideal.
The PEX line was not pressurized.
Spray foam process is done outside the CAN/ULC S705.2 Installation Standard – two 3" passes done in relative succession – second pass installed when first pass core temperature was 51.6˚C (125˚F)

PEX hose at 3.5" from substrate



PEX hose at cavity midpoint

Similar to the *Boreal Elite* test cavities, the three *Floraseal* test cavities resembled site condition construction.

CAVITY A – BEST PRACTICE INSTALLATION

PEX line located ½" from the substrate with connection at the horizontal and vertical mid-point of the cavity. This assembly represents PEX best practice installation.
The PEX line was set at a pre-spray setting of 80psi to simulate field test conditions.
Spray foam process done in accordance with the CAN/ULC S712.2 Installation Standard – one 8.5" pass.

CAVITY B – OUTSIDE ACCEPTED INSTALLATION STANDARD

PEX line located 3.5" from the substrate with connection at the horizontal and vertical mid-point of the cavity. This assembly has the PEX placed in a location that is not considered ideal.
The PEX line was set at a pre-spray setting of 80psi to simulate field test conditions.

Spray foam process done in accordance with the CAN/ULC S712.2 Installation Standard – one 8.5" pass.

CAVITY C – OUTSIDE ACCEPTED INSTALLATION STANDARD – NO PEX PRESSURE

PEX line located 3.5" from the substrate with connection at the horizontal and vertical mid-point of the cavity. This assembly has the PEX placed in a location that is not considered ideal.
The PEX line was not pressurized to simulate field test conditions.
Spray foam process done in accordance with the CAN/ULC S712.2 Installation Standard – one 8.5" pass.

Equipment settings –

Graco E30 for *Boreal Elite*:

A-side pressure -	1142 psi
B-side pressure -	1080 psi
A-side heater -	105˚F (40.5˚C)
B-side heater -	105˚F (40.5˚C)
Hose heater -	107˚F (41.7˚C)

Graco E30 for *Floraseal*:

A-side pressure -	1104 psi
B-side pressure -	1038 psi
A-side heater -	130˚F (54.4˚C)
B-side heater -	130˚F (54.4˚C)
Hose heater -	132˚F (55.6˚C)

Material settings –

Boreal Elite Lot Number -	24314
Floraseal Lot Number -	24282
Common ISO Lot Number -	033488621

Substrate (OSB) conditions –

Ambient temperature -	68˚F (20.0˚C)
Substrate temperature -	69˚F (20.6˚C)
OSB moisture content -	9.6%
Humidity -	38.2%

The Test Results

Boreal Elite

CAVITY A:

Pressure before spray -	80 psi
Pressure immediately after spray -	98 psi
Pressure one hour after spray -	95 psi
Pressure after twenty-four hours -	80 psi
Temperature immediately after spray -	118˚C (244˚F)
Temperature one hour after spray -	88˚C (190˚F)
Temperature after twenty-four hours -	20˚C (69˚F)

Visual inspection – no visible damage or distortion of tubing and/or connection

CAVITY B:

Pressure before spray -	80 psi
Pressure immediately after spray -	102 psi
Pressure one hour after spray -	100 psi
Pressure after twenty-four hours -	80 psi
Temperature immediately after spray -	134˚C (272˚F)
Temperature one hour after spray -	116˚C (241˚F)
Temperature after twenty-four hours -	20˚C (69˚F)

Visual inspection –

- ✓ no visible damage or distortion of tubing and/or connection
- ✓ *Boreal Elite* had a density that would fail the CAN/ULC S705 standard because of thickness
- ✓ Some charring of the foam visible due to the very high exothermic reaction

CAVITY B: Unpressurized sample

Temperature immediately after spray -	147˚C (297˚F)
Temperature one hour after spray -	132˚C (269˚F)
Temperature after twenty-four hours -	20˚C (69˚F)

Visual inspection –

- ✓ no visible damage or distortion of tubing and/or connection
- ✓ *Boreal Elite* had a density that would fail the CAN/ULC S705 standard because of excess pass thickness
- ✓ Charring of the foam visible due to the very high exothermic reaction due to the excess pass thickness

Floraseal

CAVITY A:

Pressure before spray -	80 psi
Pressure immediately after spray -	99 psi
Pressure one hour after spray -	96 psi
Pressure after twenty-four hours -	80 psi
Temperature immediately after spray -	100˚C (212˚F)
Temperature one hour after spray -	74˚C (165˚F)
Temperature after twenty-four hours -	20˚C (69˚F)

Visual inspection – no visible damage or distortion of tubing and/or connection

CAVITY B:

Pressure before spray -	80 psi
Pressure immediately after spray -	104psi
Pressure one hour after spray -	100psi
Pressure after twenty-four hours -	80 psi
Temperature immediately after spray -	104˚C (219˚F)
Temperature one hour after spray -	79˚C (174˚F)
Temperature after twenty-four hours -	20˚C (69˚F)

Visual inspection – no visible damage or distortion of tubing and/or connection

CAVITY C: Unpressurized sample

Temperature immediately after spray -	102˚C (216˚F)
Temperature one hour after spray -	77˚C (171˚F)
Temperature after twenty-four hours -	20˚C (69˚F)

Visual inspection – no visible damage or distortion of tubing and/or connection

'Boreal Elite' – Cavity A

'Boreal Elite' – Cavity A

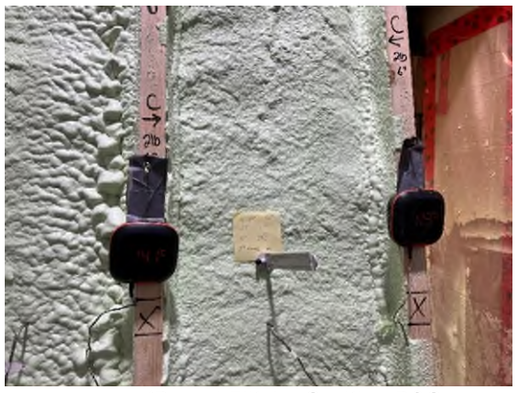
GENYK POLYURETHANE

SPRAY FOAM AND PEX TUBING

Dispelling Compatibility Myths with Laboratory Testing

'Boreal Elite' – Cavity B

'Boreal Elite' – Cavity B



'Boreal Elite' – Cavities B&C

'Floraseal' – Cavities A,B&C

Boreal Elite – Cavities A,B & C

Genyk Polyurethane
1701 3rd Avenue, Shawinigan, Canada G9T 2W6
genyk.com | info@genyk.com

Observations

1. There was no visual evidence of PEX failures of any kind in any of the tested assemblies. PEX tubing retained the original shape and flexibility.
2. The internal temperature of the spray foam materials has a direct relationship on the pressure within the PEX tubing. As temperatures rise so does the internal pressure of the PEX tubing.
3. At thicknesses outside the CAN/ULC S705.2 Installation Standard protocols, *Boreal Elite* loses density and can char within the foam depending on the thickness. While this is information previously established, continued awareness of the dangers of exceeding the S705.2 Installation Standard is worth repetition. A six-inch pass of closed-cell spray foam is not acceptable in any setting other than the research laboratory.
4. There is a direct relationship between exothermic temperatures and pressure within the PEX tubing. Thus, when sprayed in accordance with good installation practices, the potential for pressure increase is better controlled. Best practice installation strategies included at the end of this paper should be always followed.
5. *Boreal Elite* and *Floraseal* are very low exothermic reaction compared to other brands of closed and open-celled spray foam. While the Genyk materials exhibited compatibility with PEX, and further, there was no negative impact on the PEX connections, the control of exothermic temperatures has a direct benefit to PEX/spray foam stability.

A Final Word

It should be noted that Genyk *Boreal Elite* has a very low exotherm when compared to competing brands of closed-cell spray foams. The information contained within this study is wholly based on the use of *Boreal Elite*. Elevated exothermic reactions of other closed-cell spray foam materials may have the undesirable effect of creating increased pressure on the PEX tubing.

Similar to *Boreal Elite, Floraseal* has a comparatively low exotherm. Undoubtedly, the lower than typical internal temperatures of both Genyk products, is responsible for the successful compatibility with PEX materials. However, not all spray foam materials have exotherm reactions that are comparable to Genyk products. Please be advised that this project is specific to Genyk products.

Best Practices

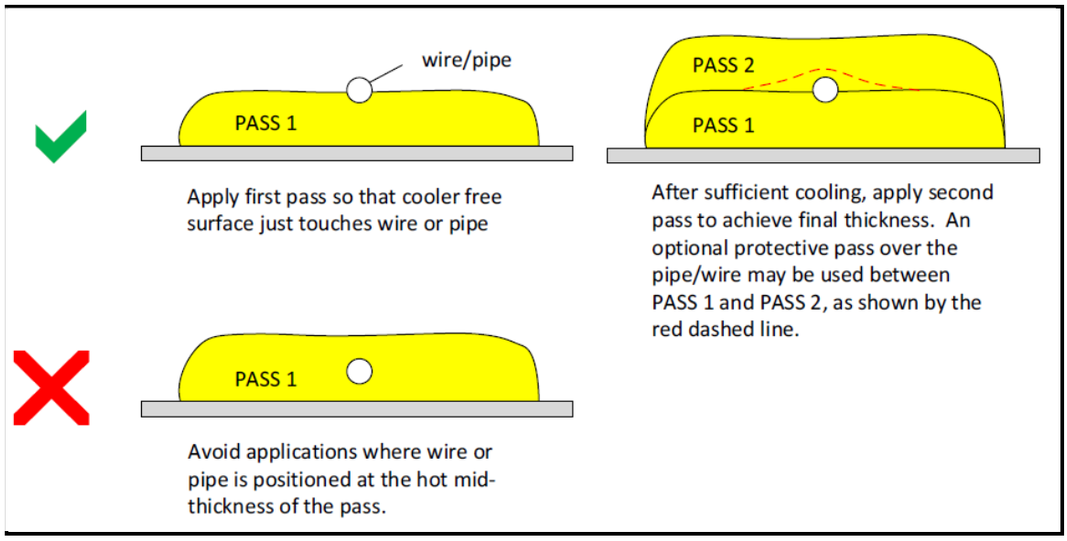
Laboratory research has the potential to inform best practice in the construction. In conjunction with published documents by the PEX industry as a whole, Genyk has matched the limitations of PEX with the physical performance of spray foam materials. This information forms the basis of the below mentioned ‘best practices’ of spraying foam with PEX tubing.

PEX tubing is made from thermoplastic materials and will soften and melt at elevated temperatures. These plastic materials can withstand continuous elevated temperatures. Further, the shorter term (static) temperatures that the products can withstand for short periods is much higher. The continuous use operating temperature of PEX varies with service pressure. The static temperatures are determined in a pressure-free testing environment.

Continuous Operating Temperature (F)	Maximum Pressure Rating (psi)	Rated Static Temperature (F)	Maximum Exothermic Temperature of ‘Boreal Elite’ @ 50mm (F)	Maximum Exothermic Temperature of ‘Floraseal’ @ 215mm (F)
200 180 120 74	80 100 130 160	295	244	219

To avoid thermal damage to the PEX, the installer should:

1. When using *Boreal Elite,* never exceed the maximum 50mm pass thickness as defined by CAN/ULC S705.2. Maximum pass thicknesses control exothermic temperatures.
2. Always install spray foam materials to PEX tubing that is de-pressurized. Pipes may contain air but should not be pressurized during application. The exothermic pressure of spray foam could increase the pressure within the PEX tubing beyond recommended safety limits.
3. Install *Boreal Elite* so that the PEX tubing is not positioned in the mid-thickness of the pass. Shown below.



NOTE 1: Some PEX manufacturers prohibit the application of spray foam over certain pipe fittings. The spray foam can be applied to the pipe, but the fittings must not be in direct contact with the foam. The installer needs to check on this prior to spraying foam around any plastic pipes. To avoid chemical contact with fittings, the installer can wrap the fittings in aluminum foil prior to foam application to provide a chemical barrier.

NOTE 2: If any spray foam liquid is spilled on plastic pipes, the liquid must be cleaned off immediately. Do not spray over a plastic pipe that has spilled chemical systems liquid on it.

NOTE 3: Water supply piping should not be located either outside or within the insulation inside exterior walls. These pipes may freeze during extreme cold temperatures. As an insulation contractor you should caution builders about location of any water piping positioned inside thermal insulation in exterior walls and suggest placing all water lines completely inside the thermal envelope of the building.

To be certain, *Boreal Elite* and/or *Floraseal* will not damage PEX piping if best practice installation methodology is implemented.

[i] Porter, Duncan and Bogden. “Update on Compatibility Testing of Spray Polyurethane Foam with cPVC”, 2008.
[ii] Villa, Bob. “All You Need to Know About PEX Pipe”, Feb, 2021, https://www.bobvila.com/articles/pex-pipe/#:~:text=Today%2C%20PEX%20is%20used%20in,construction%20residential%20water%20supply%20systems