

**SPACE SUIT SURVIVABILITY ENHANCEMENT  
NASA RESEARCH ANNOUNCEMENT 96-OLMSA-01B**

Advanced Life Support and Environmental  
Technologies for Human Exploration and  
Development of Space

**STATUS REPORT**

3/17/98

Purchase order placed with Philadelphia College of Textiles and Science. Conducted two meetings with Dr. Christopher Pastore and Dr. Moishe Garfinkle to review the project scope and develop concepts for self-sealing material compositions. Focus has been on developing concepts which would seal a penetration enough to allow the astronauts to re-enter the spacecraft within the window provided by the emergency air supply. Concepts discussed include:

- quilted fabrics containing a viscous flow material in the quilted cells which would seal the bladder breach when forced to flow by the internal suit pressure.
- a sealant impregnated felt liner which acts similar to above.
- a "blousy" fibrous layer which would mechanically plug a rupture under pressure.

Illustrations of the above concepts are included in the attached presentation.

The most promising of these concepts will be made into prototypes for testing. ILC has developed a test fixture to test the sealing characteristics of various material layups by measuring real-time changes in pressure and make-up flow in a pressurized cylinder.

Candidate viscous sealing compounds such as silicones and urethanes have been identified. These compounds will be coated on existing bladder cloth for initial tests. The most promising compounds will be integrated into the above material structures for final testing.

Design and analysis of fabric weaves to improve cut and puncture resistance of the suit TMG layers is underway. Philadelphia Textile is developing a mathematical model to correlate yarn type and weave structure to cut and tear resistance. The computer mathematical modeling of the fabric failure mechanisms by Cornell University, as originally proposed, will be replaced with the above model and empirical testing methods. This change of approach is due primarily to the fact that Cornell could not execute their proposed tasks due to loss of key personnel.

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# **Self-sealing concepts**

**Moishe Garfinkle and Chris Pastore**

**Philadelphia College of Textiles and Science**

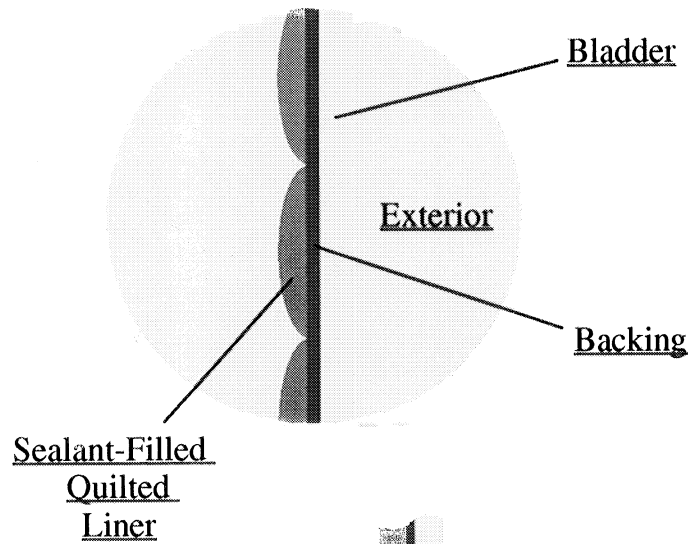
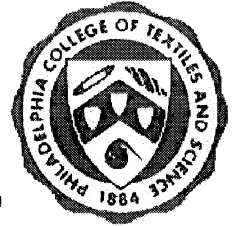
# Liquid Sealant Concepts

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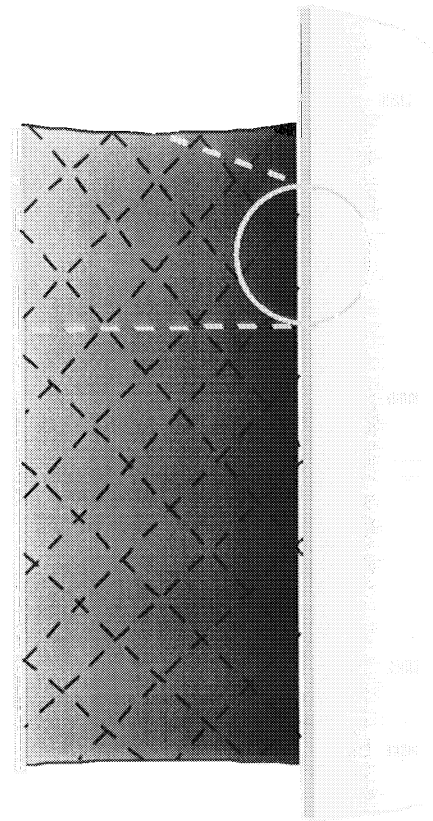
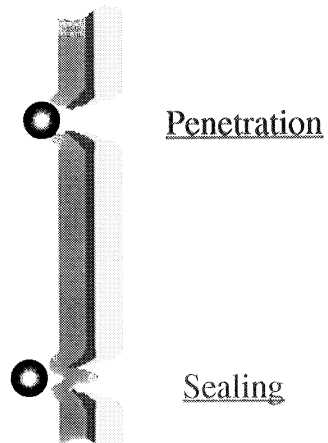


- ◆ Quilted Sealant
  - ❖ quilted layer incorporates sealant near bladder
- ◆ Impregnated Felt
  - ❖ layer of felt holds sealant stable near bladder

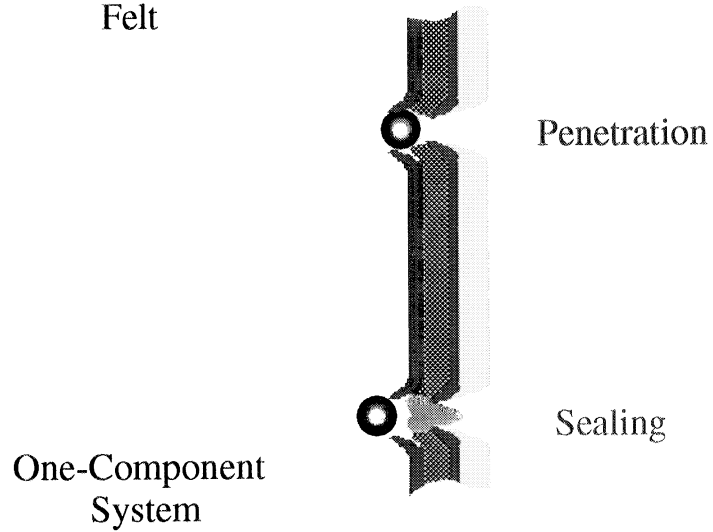
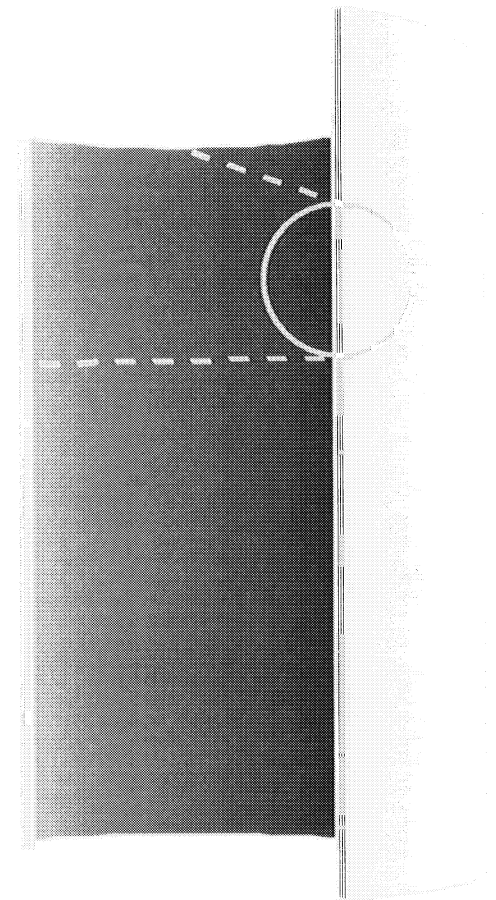
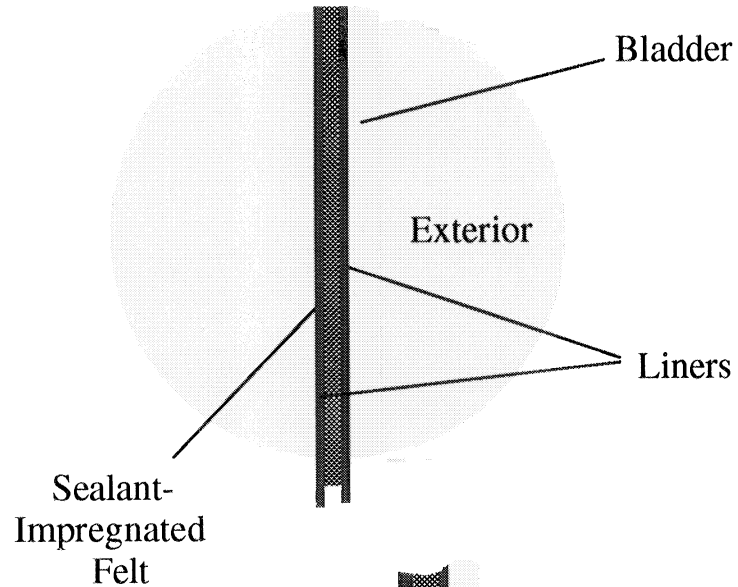
# Quilted Sealant

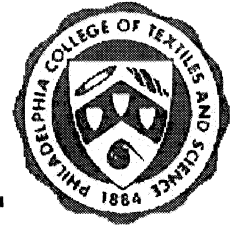


One-Component  
System



# Impregnated Felt





# Foaming Concepts

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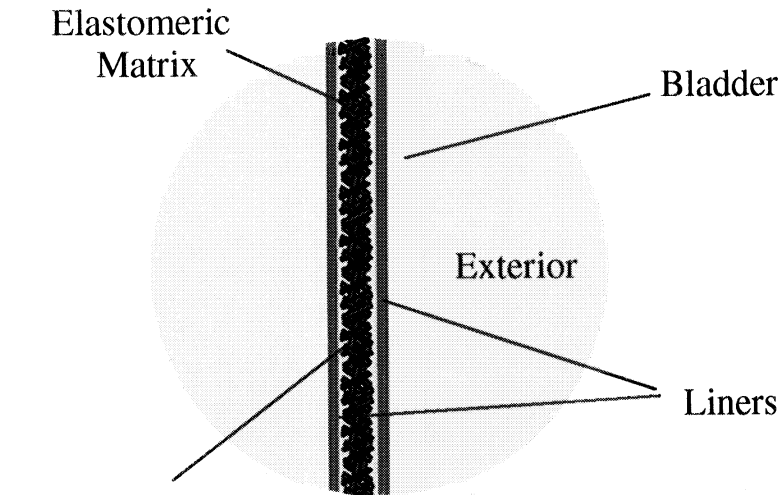
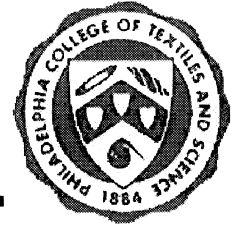
## ◆ Filled Fibers

❖ hollow fibers filled with foaming reagents form layer/fabric. When ruptured, reagents mix and react to seal.

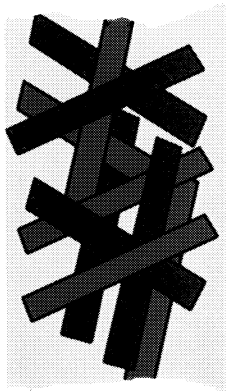
## ◆ Embedded Capsules

❖ micro-encapsulated foaming reagents embedded in elastomer. When ruptured, reagents mix and react to seal

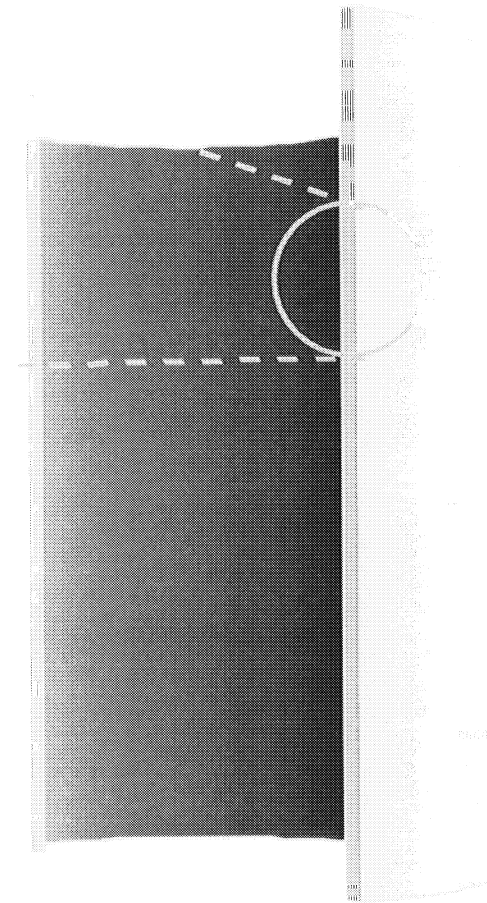
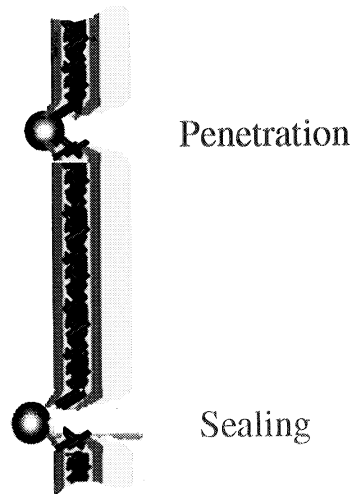
# Filled Fibers



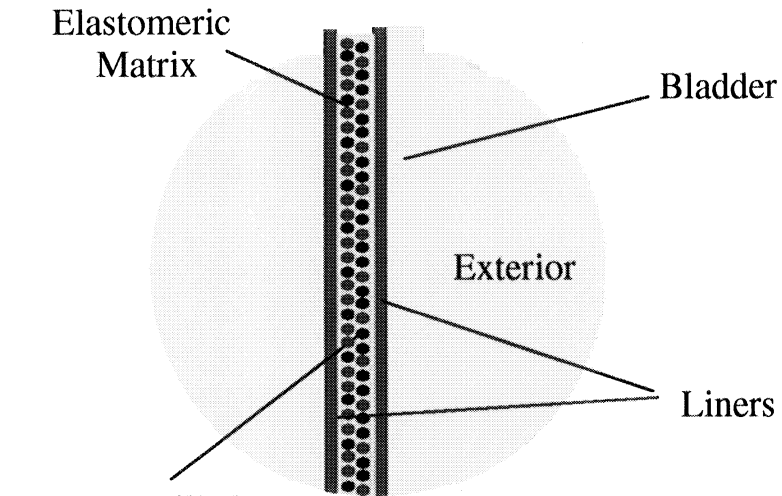
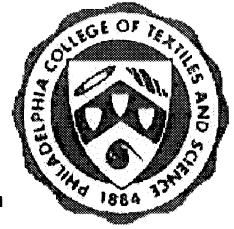
Reactant-Filled  
Hollow  
Fibers



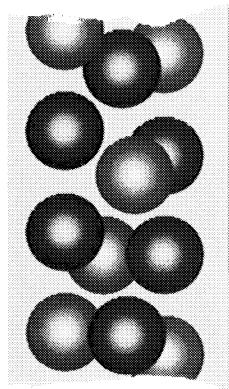
Two-Component  
System



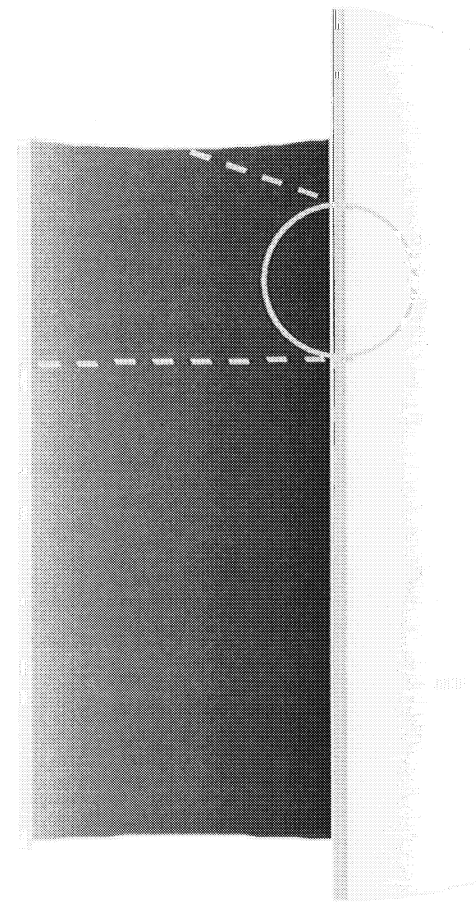
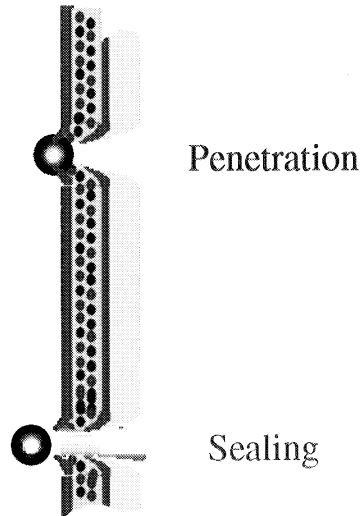
# Embedded Capsules



Reactant-Filled  
Embedded  
Capsules



Two-Component  
System





# Mechanical Sealant

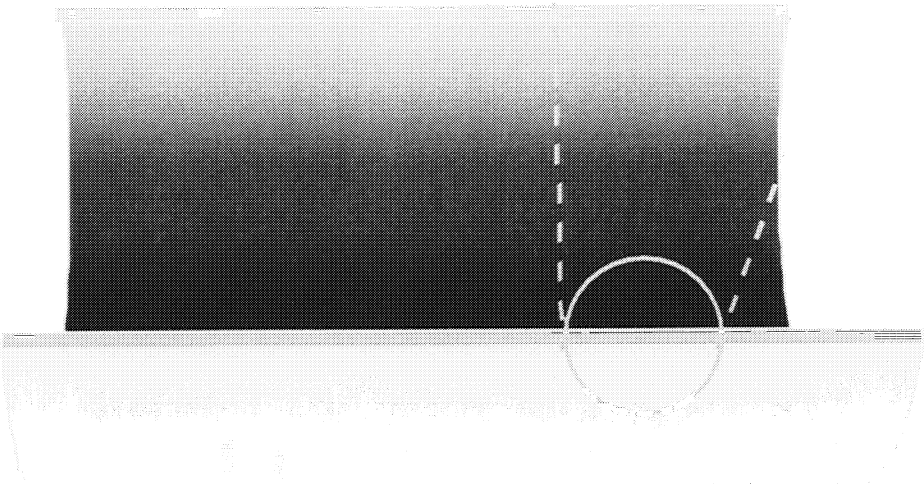
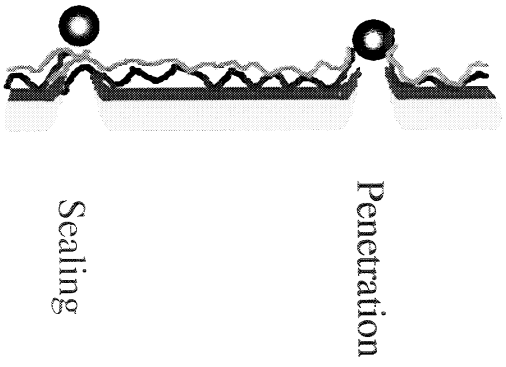
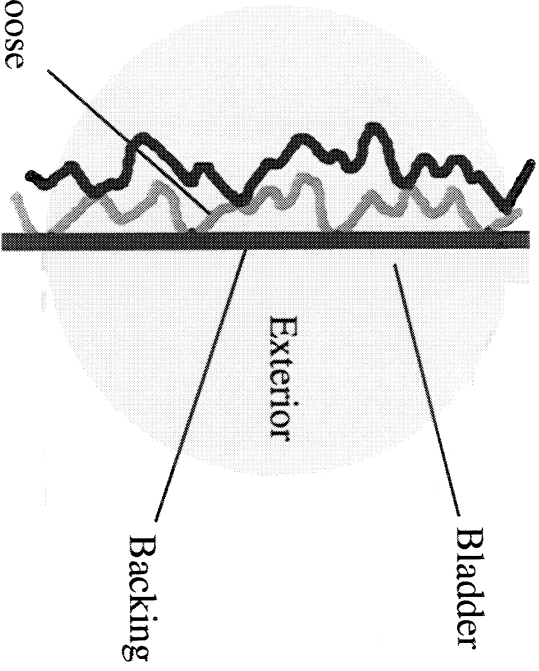
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## ◆ Blousy Fabric

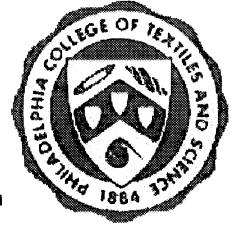
- ✦ Oversized blousy fabric is beneath bladder.  
When ruptured, air flow pulls fabric through  
puncture.

# Blousy Fabric



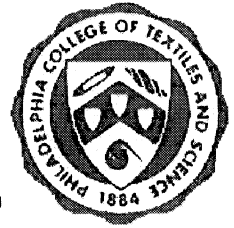
# Environmental Response

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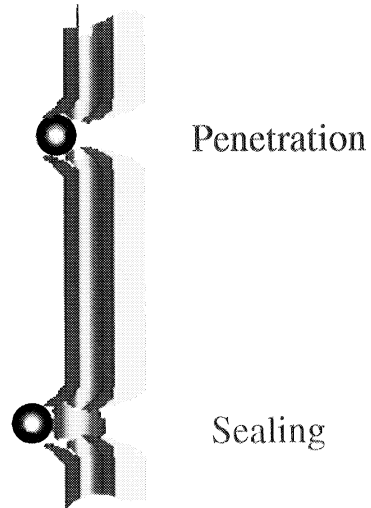
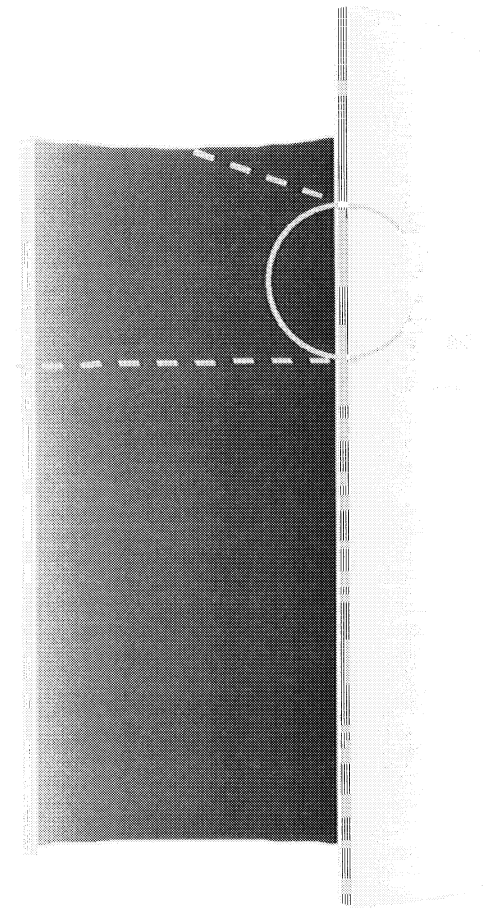
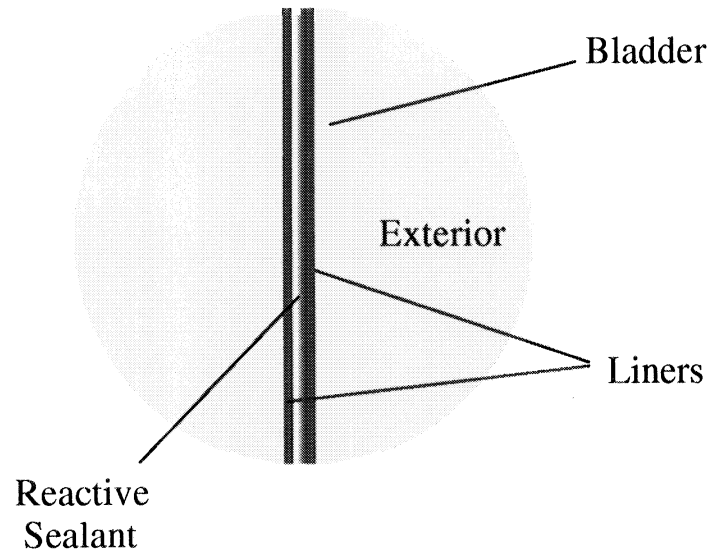


## ◆ Reactant Layer

- ❖ Low viscosity elastomer rapidly increases in viscosity when exposed to moisture.



# Reactant Layer



Two-Component System