DURABILITY

Teflon® -coated fiberglass structures have been in use for almost 30 years, but many people continue to wonder what the actual lifespan might be.

The answer to this frequently asked question, from a technical standpoint, is that we do not have sufficient scientific data to project beyond 30 years. This is based on a wide body of data on the strength retention of SHEERFILL® fabrics over the last 30 years. A combination of accelerated weathering tests, long term exposure on test racks and samples from installed buildings indicate that strength retention is well above design safety factors for strength loss.

After 20 years of actual use in the field in all types of climates around the world, no loss of translucency, yellowing degradation of the coating or loss of self-cleaning has been observed. This is consistent with the proven basic physical characteristics of inertness and excellent weather resistance of Teflon® composite.

Structures are designed around the strip tensile or breaking strength of the fabric. Other properties such as flexural resistance and tear resistant are also important.

In the critical area of strip tensile strength, the SHEERFILL® data collected to date shows a maximum of 30% strength loss and a leveling off at that value over time.

With nearly 30 years of actual installed performance, SHEERFILL® fabrics show no loss of dirt shedding, translucency, white color or other aesthetic characteristics. Actual structural strength retentions have proven the safety factors in use to be conservative. On the basis of the above we feel very confident of life spans in excess of 30 years with much longer periods of time a distinct possibility.

MAINTENANCE

SHEERFILL® membranes require virtually no maintenance other than periodic inspections or if necessary an occasional wash down of the surface. Because the fabric panels are heat sealed together in the factory, there is no opportunity for leakage if the structure is a single integrated unit.

The need for interior maintenance is also reduced since the underside acts as a finished surface. And this surface will never require painting.

The possible need for access to the exterior surface of the fabric is a consideration that should be addressed in the design phase. Tensioned fabric will easily support a man, but the location of tie-off points should be explored.

CLEANING

SHEERFILL® Architectural Membrane, typically requires no cleaning after installation. However, situations may exist where the self-cleaning properties of the fabric cannot be fully realized. These conditions would include areas that have little yearly rain or congested metropolitan areas where airborne soot, dust and oil particles are constantly being deposited on the fabric.

To clean SHEERFILL® membrane that has become dirty, care should be taken in the choice of cleaning solution and method of loosening the dirt for removal.

The only recommended soap for the cleaning operation is MURPHY'S OIL

SOAP® Household Cleaner. Because of its excellent cleaning properties, only one third (1/3) of a fluid ounce per gallon of water is needed (one (1) cup soap per twenty-four (24) gallons of water).

To loosen the dirt, only soft nylon bristled brushes should be used.

FUTURE REPLACEMENT

The ability to enact repairs or replace a fabric panel without the necessity of completely closing off the space below is an attribute that is important to high traffic applications such as malls or airports.

Birdair maintains engineering and patterning information for all completed projects, which allows us to quickly fabricate a replacement panel, should this become necessary. In general, the replacement of a panel or bay of fabric is accomplished by tensioning the fabric over top of the existing area to be replaced. The fabric is then heat sealed or mechanically clamped to the existing structure and the old panel is then removed.

Using this procedure, either a single panel or the entire fabric structure can be replaced with minimal disruption of the activities going on below the area.

POSSIBLE EFFECTS OF AIRCRAFT FUEL/EXHAUST

The possibility of damage occurring to the SHEERFILL® Architectural Membrane as the result of exposure to aircraft fuel or exhaust is minimal.

The Teflon® coating on the fabric is inert and as such does not react when it comes in contact with a substance such as the aircraft fuel or exhaust mentioned above.
If fuel is inadvertently dropped on the fabric roof it may require cleaning as described elsewhere in this report.

The acceptability of this material for airport related structures are evidence of its performance capabilities and durability. Airport applications utilizing SHEERFILL® Architectural Membrane include:

	Year Completed
San Jose de Los Cabos Intl. Airport Los Cabos, Mexico	2001
Orlando International Airport Phases I and II Orlando, FL	2001 1999
Jacksonville International Airport Phases I, II and III Jacksonville, FL	2001 1997 1991
Palm Springs International Airport Palm Springs, CA	1999
Denver International Airport Main Terminal - Denver, CO	1993
Jacksonville International Airport Jacksonville, FL	1991
Royal Saudi Air Force Peace Shield Al Karaj Airbase, Saudi Arabia	1991
Miami Airport North Terminal - Miami, FL	1985
Hangar One, Tampa Airport Tampa, FL	1981
The Haj Terminal Jeddah, Saudi Arabia	1981

Riyadh International Airport 1981
Riyadh, Saudi Arabia

FIRE RATING

All SHEERFILL® fabrics are Class A for spread of flame and have smoke generation values less than 10, in accordance with ASTM E108 "Standard Methods of Fire Tests of Roof Coverings" and ASTM E84 "Standard Methods of Test of Surface Burning Characteristics of Building Materials".

All SHEERFILL® fabrics pass for substrate compliance and are defined as non-combustible; in accordance with ASTM E136 "Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees Celsius".

As a result of the fire resistance of SHEERFILL® fabrics, they can be used in virtually all types of construction.

MECHANICAL PERFORMANCE

OPERATING COST

An accurate projection of the costs associated with using a SHEERFILL® Architectural Membrane glazing system, as opposed to glass skylighting or conventional roofing, is not possible, without a complete mechanical systems analysis. But there are some general conclusions that can be drawn about the operating cost of a fabric roof system.

These conclusions include:

- The thermal performance or heat loss of a fabric roof will be comparable to glass skylighting, but neither fabric nor glass can approximate the thermal performance of an insulated conventional roofing system.
- Lighting costs can be significantly decreased by utilizing a fabric or glass skylight. But a translucent fabric skylight offers significant interior lighting to a structure without introducing excessive heat gain. This is illustrated by considering that on a bright clear day on June 21st at noon is approaching 10,000 fc outside. With a 10%T product the light intensity on the
- inside of the skylight would be approximately 1,000 fc. An overcast day on the 21st of December at noon is approaching 2,000 fc and using the same %T will yield 200 fc. In most single story structures this will provide more light than artificial lighting design levels. Most shopping mall common areas are illuminated to 1.5 to 2.0 watts per sq. ft. or roughly 25 to 40 foot-candles.
- The main features of SHEERFILL® Architectural Membrane that produce low cooling requirements are the low shading coefficient and low amount of reradiated heat due to low absorption.
- In applications where cooling load is the dominant energy requirement, such as a retail mall, SHEERFILL® Architectural Membrane's low solar gain gives it a significant advantage over glass skylighting.
- A comparative energy consumption analysis of SHEERFILL® Architectural Membrane vs. conventional insulated roofing systems demonstrate favorable performance in cooling conditions. Much of this energy performance data can be viewed in the table included as Attachment E.

THERMAL PERFORMANCE

SHEERFILL® membrane skylights have thermal resistance values (U-Factors) comparable to glass or other glazing systems. A single membrane is roughly equivalent to R-1 (U = 1 BTU/sq. ft./degree F/hr.). Fully sealed double membrane roof systems are roughly R-2 (U = .5 BTU/sq. ft./degree F/hr.). A table displaying the actual values is included as Attachment A.

For retail malls, cooling loads typically far outpace thermal performance in level of importance.

CONDENSATION

The potential for the formation of condensation within a structure is a function of the range in temperatures and humidity for the area and the air movement of the structure.

The presence of a liner in a fabric structure plays a significant role in the expected frequency of condensation. The liner has the desirable effect of adding insulation to the roof and therefore saves energy and creates a more comfortable space. The effect of this is to cause the outer fabric to be colder during heating seasons (and therefore less heat loss from the building).

The decision to utilize a liner in a fabric structure should be based on a number of considerations that includes: a desire for increased thermal performance, achieving a specific, usually lower, light transmission level, better acoustical properties, or for aesthetic or design reasons.

If the decision is made to include a liner, the design should incorporate a drainage system. If condensation forms on he underside of the exterior fabric it will run down the liner into the drainage system and out of the structure. In addition, consideration should be given to introducing HVAC treated air between the fabric layers as a way of minimizing or possibly eliminating condensation. This has been used quite successfully on the Sherway Gardens Mall in Toronto, Ontario.

VENTILATION

Decisions regarding the ventilation of a fabric structure are governed by local building codes and the mechanical considerations and requirements of the individual design.

SOLAR GAIN

SHEERFILL® Architectural Membranes produce significantly lower cooling requirements than conventional glass skylights. This superior performance is a result of low solar transmission, ranging from 7% to 24%, and low solar absorption, ranging from 10% to 18% for single membranes.

The net result is a product with a very low shading coefficient and a low amount of reradiated heat due to low absorption. Low shading coefficients can be achieved with highly tinted glass (black reflective glass has a shading coefficient of .18) but the solar absorption increases dramatically. The net result is heavy heat input from reradiation of the absorbed heat.

The reason for SHEERFILL®'s low absorption is its high solar reflectivity, generally 70% or greater. This characteristic of the product is maintained throughout the life of the structure because of the self-cleaning nature of the Teflon® -coating.

Comparative energy consumption analysis of SHEERFILL® vs. conventional insulated

roofing systems demonstrate favorable performance in cooling conditions.

ACOUSTICS

INTERIOR CONSIDERATIONS

Interior spaces are usually designated to have an overall noise criterion (NC), which prescribes the maximum permissible background noise level. The NC level varies from a low of approximately NC-20 in concert halls to a high of approximately NC-50 in sports facilities. Background noise is produced by exterior noise intruding into the structure (discussed below) and from mechanical systems, which are outside the scope of this discussion.

Reverberation is a separate interior consideration. Reverberation time is directly proportional to room volume, and inversely proportional to absorption. Short reverberation times are necessary for good speech intelligibility. Small meeting rooms are seldom a problem, but larger enclosures such as fieldhouses, aquatic centers and stadiums are significantly more difficult to treat effectively.

Generally, fabric roofs and skylights are virtually transparent to low frequency noise (up to 63Hz). Therefore, reverberation in those frequencies is well controlled.

In large areas or areas requiring special treatment, the addition of an interior membrane of FABRASORB® should be considered. The NRC of the composite system is significantly higher than that of a single fabric cover and it contributes much more absorption than conventional rigid glazing.

EXTERIOR - INTERIOR ATTENUATION

One of the major advantages of a fabric structure, its lightweight construction, is a disadvantage when considering exterior - interior attenuation. Attenuation improves with increasing mass.

Based on known or estimated STC ratings, we have estimated the dBA difference between the exterior and interior noise levels that each is capable of providing.

SHEERFILL® or similar fabric - est. 10 dBA for a single layer of either SHEERFILL® I or SHEERFILL® II (the difference between them is max. 2dB); might achieve 15 to 20 dBA with two layers of the material spaced several inches apart. Single-glazed skylights - est. 25 dBA; double-glazed, if spaced well apart, up to 40 dBA.

ACOUSTICAL CONSIDERATIONS - EXTERNAL AIRCRAFT NOISE

During the development phase of the Denver International Airport, which has a 250,000 square foot tensile membrane roof, with a FABRASORB® Acoustical Membrane liner on the main terminal, the project team was obviously concerned with the possible impact of aircraft noise on the interior of the structure.

The architect commissioned a study to be performed by acoustical consultants Shen Milson & Wilke, Inc. of New York. Their conclusion statement follows:

"Our conclusion is that the proposed design satisfies the acoustic requirements for an airport type facility. The perceived aircraft noise will generally be of a low frequency character and will be clearly audible within the atrium on an intermittent basis. However, the noise is not expected to interfere with airport operations, nor be

annoying or uncomfortable to the building occupants and will not interrupt normal conversation or the intelligibility of public address systems".

POSSIBLE EFFECTS ON RADAR

Teflon® -coated fiberglass fabric was originally engineered to conceal and protect sensitive radar installations. The fabric has excellent dielectric properties and is electromagnetically transparent. But probably the clearest indication that the Teflon® -coated fabric does not adversely effect airport radar is the fact that the U.S. Federal Aviation Administration has requested that architects specify it into all new major airport control towers.

FABRICATION AND INSTALLATION

Birdair, Inc. has a single administrative and manufacturing facility located in Amherst, New York (near Buffalo).

We typically perform project engineering, fabric design, fabric fabrication, purchasing of fabricated materials (structural steel, cables, aluminum clamping/hardware, glass skylights), quality assurance and project management from our Amherst facility.

Birdair typically is involved early in the development process of a fabric structure. We offer value engineering suggestions for existing design schemes, details, budgeting and preliminary reaction load analysis.

By working closely with the design architect and the architect's structural engineer, we are able to maximize the efficiencies of a fabric roof, and reduce the chances of an interface problem.

Typically at the time Birdair develops a proposal package for a project, a project management team is assigned. The team includes: a business development manager, who coordinates the pricing and technical support; a project manager, who develops the installation procedure, reviews the commercial considerations and oversees the construction; a project engineer, who analyzes the proposed scheme, develops details and provides a technical interface for the project structural engineer.

Birdair maintains a staff of experienced and skilled installers that move from job site to job site installing the material described above. For projects being constructed in the U.S., Birdair typically assumes responsibility for the complete installation of the tensile membrane structure.

In foreign markets where Birdair is less familiar with local customs, regulations and costing, we prefer to team with a local entity capable of supplying the proper construction equipment and skilled manpower. In this situation Birdair would offer experienced construction supervisors to guide the fabric structure installation.