

# POLYISOBUTYLENE (PIB) SINGLE-PLY MEMBRANES

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In 1974, at the First International Roofing Symposium on Roofs and Roofing in Brighton, Great Britain, three predictions were made concerning synthetic single-ply roofing systems.

- Synthetic roofing membranes in short single-ply systems will achieve larger market shares because of their undeniable advantages in material properties, controllable production techniques, performance behavior and ease of application.
- Considering the excellent material properties of polyisobutylene (PIB), membranes or systems made of this particular generic group are supposed to have the widest recognition and, more importantly, the largest opportunities for growth.
- After the general introduction of loose-laid or so-called ballasted application methods, more innovation and development in regard to material properties, testing standards and application techniques are to be expected. This means material-related criteria, such as those for lap seams, cross joints and flashings, must be refined and simplified. Application requirements also must be made easily understandable to the roofing contracting industry.

Today, 11 years after the symposium in Brighton, we may ask if these three statements were valid. Indeed they were!

- Referring to statement one, single-ply membranes have dominated the market in Europe and the use of synthetic or modified roofing systems in the United States has boomed.
- Referring to statement two, more than 1 billion square feet of PIB roof systems have been sold and installed worldwide during this time and now are dependably protecting valuable investments. Approximately 120 to 130 million square feet of PIB roofing membranes have already been installed in the United States, predominantly on reroofing projects.
- Referring to statement three, a wide variety of application techniques have been introduced but more importantly, responsible manufacturers have provided good to excellent technical services for project start-up, contractor training, field inspection and warranties that cover material as well as labor.

Thanks to American Society for Testing and Materials (ASTM) task forces, SPRI (Single-Ply Roofing Institute), the NRCA (National Roofing Contractors Association) and others, single-ply standards have been established, or at least have serious working groups involved to establish, more unified standards.

Individual criteria, the performance characteristics, and the meaning of different material properties for each particular generic group have been developed and published.

However, there still is a long way to go. So far, the predictions made in 1974 in Brighton, Great Britain were pretty accurate and, as we know today, the results are beyond the expectations of 11 years ago.

Three obstacles directly related to PIB were pointed out at the same symposium and were expected to be eliminated:

- The prefabrication of larger or wider PIB sheets to minimize the number of lap seams or to simplify the seam welding methods was to be accomplished.
- The tensile strengths of PIB material were considered less than other synthetic single-ply membranes and should be improved.
- A fully asphalt-bonded application, which was the most common installation method in use at the time, was to be used to reduce PIB's dependency on ballast without sacrificing the membrane's most important advantage—its inherent flexibility.

How has the PIB industry coped with these obstacles? To understand the current situation, we should start with more general terms and the basic philosophy valid for all single-ply membranes. This philosophy is particularly valid for polyisobutylene PIB single-ply membrane roof systems for flat roofs.

A common misperception is that all synthetic roofing membranes are somewhat similar because they are made from petrochemical sources and are all polymers. However, there still are significant differences between the different generic groups. There are three main material groups:

- THERMOPLASTIC (PVC)
- ELASTOMER (EPDM)
- PLASTOMER (PIB)

(Also referred to as non-vulcanized or uncured elastomer. PIB is considered a plastomer (uncured elastomer) and is placed in its own generic group)

Manufacturers divide the available single-ply systems by the method of production:

- calendared material/products;
- extruded material/products;
- combinations of both extruded and calendared material/products.

The PIB roofing system is categorized as an extruded plastomer. Extruded plastomers are materials that process like thermoplastics, yet have rubber-like properties, need no vulcanization, are elastic and, most importantly, retain a reasonable degree of inherent flexibility at low temperatures.

The development of PIB roofing and waterproofing membranes and their introduction to the market started in

the late 1920s. With the trend to more lightweight construction in the 1960s and 1970s, the PIB system was refined. The complete system now includes synthetic fleece backing, prefabricated sealing edges, and a variety of preformed accessories such as inside and outside corners, and drains and vents with pre-assembled PIB collars.

The method of PIB system installation also has changed significantly. Market-oriented companies have established technical departments with roofing consultants and contractor supervisors. These companies provide complete support for the roofing contractor to insure that the single-ply systems are properly installed. Material-related specifications and instructions for laying also have been developed. What are the advantages of the PIB system?

- Longevity, weather and ultraviolet radiation resistance, etc.
- No plasticizer, therefore no migration problems.
- Easy and safe connection at the membrane seams.
- No flashing problems on protrusions and terminations. All flashing is done with PIB material; no coated metal, wood nailers, etc. are needed to insure the integrity of the PIB system itself.
- Excellent behavior at low temperatures, with no shrinkage.
- Asphalt compatibility.
- Can be installed using hot asphalt or cold-process adhesive.
- No ballast or mechanical fastening necessary.
- Two colors available: black or white.
- In the United States, both systems are in accordance with ASTM standards and are FM class A I-90 approved and U.L. Class A listed.
- The systems carry a 10-year materials and labor warranty.
- During the recession of the 1970s and early 1980s, when the construction market for industrial roofing was relatively small, the polyisobutylene system proved to be an excellent reroofing or retrofitting system. In the United States, more than 95 percent of the PIB roofing systems have been installed over existing roof substrates.

How was the PIB membrane manufacturing industry able to achieve all of these advantages and even exceed the demands of modern roofing technology? Two things have contributed to PIB's success: the idea and the properties of the PIB membrane itself and the use of the product, including its field technique, installation and application.

#### **The System Itself**

The PIB roofing membrane is not simply a sheet of plain, naked material. It contains three important components:

- the polyisobutylene sheet itself, with a thickness of 60 mils;
- the non-woven, rot-proof, synthetic fleece backing with a thickness of 40 mils; and
- the 2-inch (5-centimeter) prefabricated sealing edge.

The polyisobutylene waterproofing part provides excellent resistance to weather, ultraviolet light, sparks, radiant heat, root penetration and the usual gases from industrial and heating plants. Polyisobutylene is compatible with bitumen or asphalt, contains no plasticizer, has excellent resistance to natural aging, and is non-porous.

However, polyisobutylene is not resistant to organic solvents such as benzene, toluene or petroleum, or to materials containing solvents such as lacquers, fats, oils and coal tar. Also, the temperature and concentration of this contamination may be an important factor in deciding to use the PIB system on a particular project. Knowing that PIB is not resistant to coal tar pitch does not mean it cannot be applied over coal tar on a reroofing project. Appropriate preventative actions are necessary. The technical departments of the PIB manufacturing industry are able to recommend methods of application after a careful evaluation or roof inspection has been made.

The non-woven, synthetic polyester fleece reinforcement underneath the polyisobutylene membrane provides excellent protection against structural stresses and movement, which often cause damaging tension in roof coverings. The fleece backing allows trapped moisture to be dispersed without an adverse effect (trapped moisture is a common cause of problems in traditional roofs of all types).

The reinforcement of the plain PIB membrane with the polyester fleece provides approximately a threefold increase in breaking strength, independent of any temperature. For example, once achieved, the same value remains in temperatures of 176F (80C), at room temperature and in low temperatures of -4F (-20C). This is excellent evidence of the security of the system. Since the bonding medium to hold the membrane in place only penetrates a certain amount of the fleece backing, the system itself is considered loose-laid. There is no direct contact of the bonding component with the PIB waterproof part itself. Even though it is adhered, the polyisobutylene part literally swims or floats on top of the fleece. By adhering only 50 percent of the PIB system to the substrate (according to the manufacturer's instructions), this effect will be even more significant.

The waterproof PIB part of the system is, therefore, completely separated from the roof substrate and is chemically and physically unaffected. The remaining part of the fleece backing is able to function as a vapor equalization layer. Therefore, blister development from entrapped moisture can be eliminated. Of course, this is only a general statement since every roof has its own criteria, especially after the existing roof has been affected by deterioration and leakage.

The prefabricated self-sealing edge is the most advanced feature in single-ply roofing technology. No solvent agent welding or hot air welding is necessary. The prefabricated sealing edge permits a fast, continuous method of installing the membrane. To waterproof the seam, simply remove the release paper from the properly positioned membrane and immediately tread down, taking care to avoid fishmouths. The seam should be firmly rolled with a long-handled roller.

The development, production and assembly of the sealing edge is one of the most sophisticated processes in the roofing industry. The sealing edge not only provides an absolutely waterproof seam immediately after contact with the underlying membrane, it also works as an expansion joint to release tension and stress between the membrane and the substrate.

Tension can be caused by neglecting control joints or expansion joints in the structural part of the roof deck assumably by not considering the possibility of movement in the thermal insulation, expansion and contraction created by temperature influences, by neglecting of specifications, or lack of any specifications at all.

On re-roofing projects of buildings erected 30-40 years ago, with frequently changed owners, no files of building design and drawings or structural analyses are handy. Important facts such as load-bearing capacity, calculated structure movement, etc., are neglected. A roof survey and building evaluation is seldom conducted, but when a roof fails, regardless of what reason, everyone is utterly surprised.

Unfortunately, not every salesman in the roofing industry is appropriately trained and has sufficient technical background to decide which roofing material is suitable for a particular project and which type of application should be recommended and executed. The main objective is to sell the product, and often important facts are deliberately or inadvertently neglected. However, the roofing systems still is expected to fulfill the customer's expectations. If it does not, the manufacturer's reputation suffers along with the contractor's, who is caught between the roof system supplier and his customers. Since the prefabricated sealing edge acts as an expansion joint, it is less vulnerable and tolerates some of these neglected factors.

The sealing edge component allows the seam to slide without losing its waterproof quality, so the membrane will not split or break and the seam will not be affected. The movement only takes place within the thickness of the

sealant component itself. The flanks of the component connected to the membrane surfaces are not involved, and remain neutral.

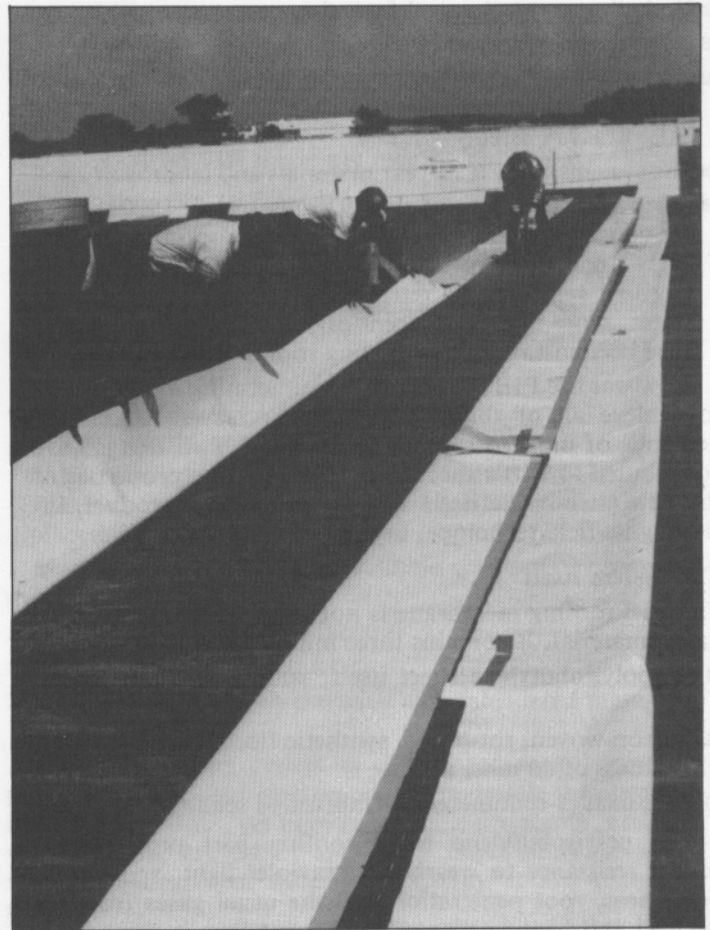
The combination of the 60-mil PIB sheet as the waterproof section, the 40-mil synthetic non-woven fleece as the reinforcement section, and the prefabricated sealing edge as the waterproof and tension-releasing part create the PIB roofing system. The PIB system is not simply a naked sheet, but a technically researched and developed system with unique specific properties that permit a variety of application and installation possibilities, insuring the characteristics required of a high-performance roofing system. The goal set by the polyisobutylene single-ply roofing system manufacturing industry has been achieved. Every roof and system is as good as its seams and connections. The burden of creating waterproof connections under continuously changing, uncontrollable weather conditions in the field has been taken away from the roofing contractors and placed in the production plant with consistently even and controllable environments.

Therefore, the manufacturers of PIB roofing systems are sharing the responsibility for the workmanship with their approved PIB applicators an area in which the roofing contractor previously has been left alone.

The following slides demonstrate the basic steps of applying a PIB Roofing System:

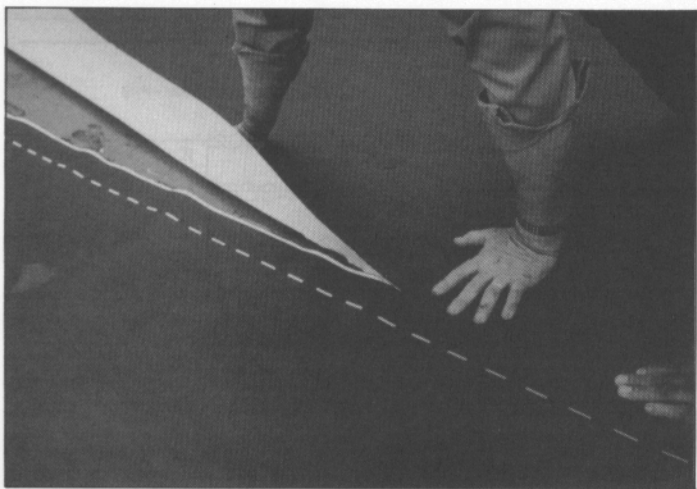


*Photo 1* Laying out the PIB membrane—2" seam overlap, controlled by alignment markers



*Photo 2* Butterflying back of two membrane halves—applying hot asphalt or cold process adhesive





*Photo 3 Folding the PIB membrane back in place*



*Photo 4 Cleaning the seam area with PIB solvent agent*



*Photo 5 Removing the seam release paper strip and trodding the seam down*



*Photo 6 Rolling the seam firmly with a long handled, 35-lb. roller*



*Photo 7 Controlling the seam with a needle probe*



*Photo 8 A completed, sloped roof—black PIB*



Photo 9 A completed, dead level roof—black PIB



Photo 10 A completed, dead level roof—white PIB

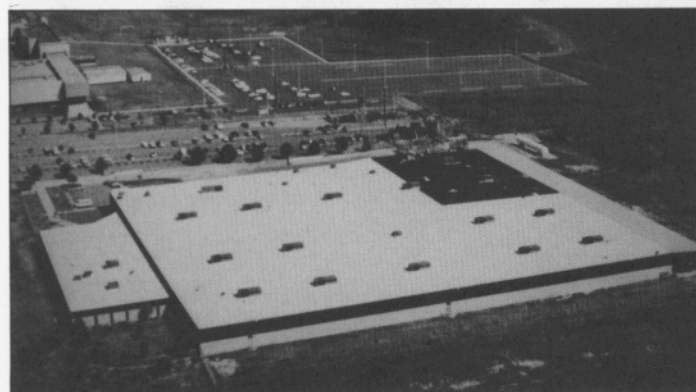


Photo 11 A completed, sloped roof—white PIB

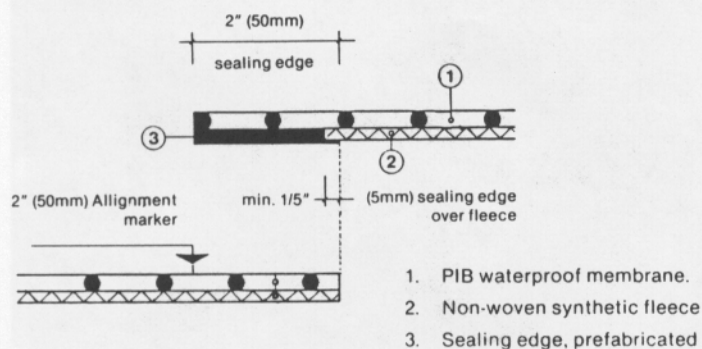


Figure 1 The PIB Roof System, not only a plain sheet

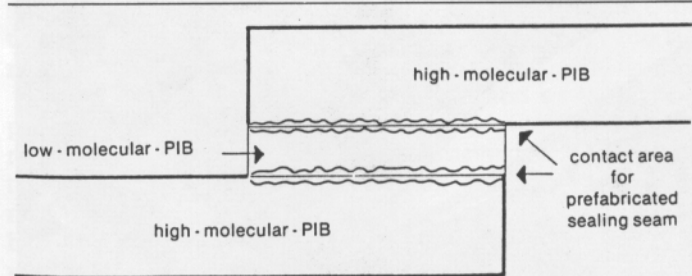


Figure 2 The PIB Roof System, the waterproof part

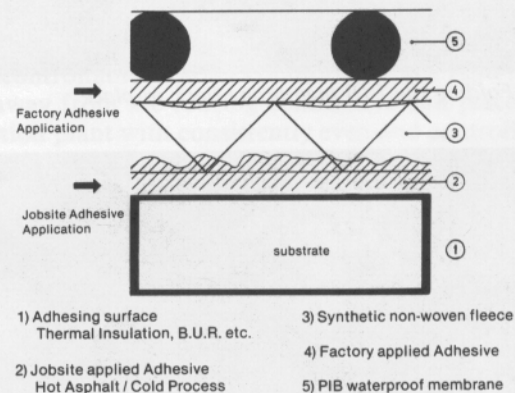


Figure 3 The PIB Roof System, the reinforcement part

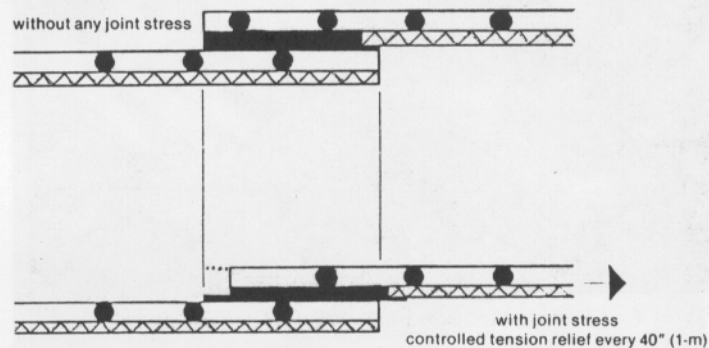


Figure 4 The PIB Roof System, the prefabricated seam

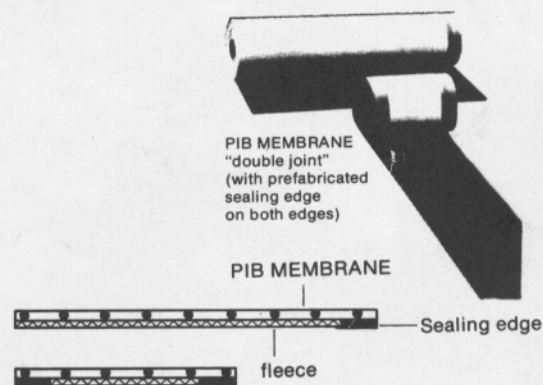


Figure 5 PIB Membrane