



EPDM in all cases, and TPO in a majority of the cases, failed to achieve Class A rating criteria.

Fire Testing – A Useful History & Uncertain Future

By James T. Knight, MRCA Executive Director and Kurt Baumgartner, MRCA Technical Advisor

MRCA first developed an interest in evaluating aged coated modified membranes – coated to obtain specified fire ratings – in 1996. The point of this initial research was to determine if and how long coated assemblies could maintain fire ratings. From this initial research it was determined that some coated assemblies did indeed lose their fire resistance over time.

MRCA recognized that this research would benefit its members in at least two ways: 1) by alerting them as to a potential liability if the systems they were applying had lost their fire ratings; and 2) by advising them how best to maintain the fire resistance of the roofs they install.

This initial research sparked two independent but interrelated programs: A 5-year MRCA coatings research program (headed by Jim Carlson of Building Envelope Technology & Research in Seattle, WA); and an ongoing fire resistance program (led by Dr. Rene Dupuis of Structural Research, Inc. in Middleton, WI).

The results of the roof coatings program will be presented during MRCA's 55th annual convention in Kansas City, October 14-15, 2004.

The fire resistance program, however, because of totally unexpected results, is currently being evaluated by a number of interested parties, in addition to MRCA.

MRCA's initial research in 1996 into modified membranes that use a coating to achieve fire resistance found that these membranes did lose fire resistance as they age. It was also discovered that recoating could restore fire resistance. At the time these findings were disclosed, there was no industry disagreement with either the science used or the results obtained from this research.

In 2001, ASTM E-108 spread of flame and burning brand tests were performed on Class-A rated PVC, TPO, EPDM, and modified bitumen membranes. Because the TPO and EPDM data was inconsistent, further testing was deemed necessary.

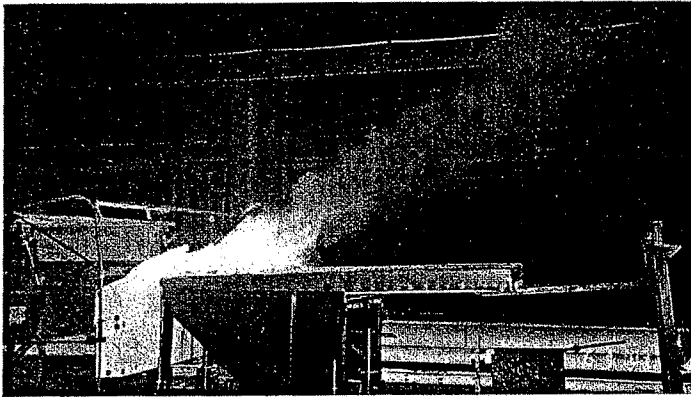
In 2002, the MRCA received additional funding to continue the work of the 2001 fire test program. The following roofing organizations and MRCA affiliates have helped to financially support this ongoing research:

- Associated Roofing Contractors of Greater Kansas City, Inc.
- Building Envelope Technology & Research
- Chicago Roofing Contractors Association
- Indiana Roofing Contractors Association
- Dixie Roofing, Inc.
- Iowa Roofing Contractors Association
- National Roofing Contractors Association
- Oklahoma Roofing & Sheet Metal, Inc.
- Omaha Roofing Contractors Association
- Ridgeworth Roofing Co., Inc.
- Southwestern Roofing & Metal, Inc.

- The McDowall Company
- The Union Roofing Contractor Members of Roofer's Local No. 2 Industry Advancement Fund
- Twin Cities Roofing Contractors Association
- Western States Roofing Contractors Association
- Wisconsin Roofing Contractors Association

These results were presented during MRCA's 2002 convention in Chicago. Unlike the previous tests conducted by MRCA, programs presenting these results brought swift and vitriolic comments from various elements of the roofing industry.

In October 2002, NRCA, as a facilitator, arranged a two-part meeting at their offices in Chicago. The first part involved manufacturers and the second involved testing agency representatives. It was discovered at these meetings that the longstanding ASTM E-108 testing protocol had been altered by at least one nationally recognized testing agency by wrapping the edges of TPO and EPDM test sample assemblies. Nowhere in the ASTM E-108 standard test method does it state that sample assemblies should or even could have their edges wrapped with membrane prior to testing. The testing facility utilized by MRCA for the conducting of fire tests was unaware of this different interpretation of the E-108 requirements.



Roofing materials are subjected to intense heat and flames in a laboratory so they may be rated for fire resistance.

Following the October 2002 meeting, enough concern was raised that MRCA and NRCA joined forces and embarked on another series of tests during 2003. The two organizations retained the services of Mr. Jess Beitel of Hughes Associates in Baltimore, MD, a nationally recognized expert in the area of fire testing, to oversee future testing and provide us with appropriate recommendations.

Further testing was then instituted in conjunction with Jess Beitel and NRCA. It was again determined only new samples should be tested. Once again, when the new material was tested, EPDM in all cases, and TPO in a majority of the cases, failed to achieve Class A rating criteria, when tested per ASTM E-108. Similar results were obtained whether the test sample edges were wrapped or not wrapped.

The results of these tests were consistent with the previous MRCA 2002 testing, and were presented at MRCA's 2003 convention in Cincinnati by Jess Beitel. Mr. Beitel's observations at that time indicated either a problem with the E-108 test procedure or with the material being tested or both. It also

appeared that the combination of the single ply membranes tested and the ISO over which they were tested was a factor in the failure. When tested separately from each other, both materials passed.

Following the MRCA convention, a meeting was held in Chicago on November 13, 2003. The meeting attracted the participation of manufacturers, testing laboratories, contractors, consultants and advisors in addition to MRCA and NRCA staff. Jess Beitel presided at that meeting.

During the meeting, Underwriters Laboratories (UL) recommended that a complaint be filed with UL under their existing "field" program. The response to such complaint would be that UL would open a "field complaint" program and run tests again from samples provided by UL representatives collected in the field. The results obtained from such tests would be reflected in a rating published in the next UL directory but would not be specifically shared with the entity making the complaint.

UL stated that they could obtain materials from the various manufacturers while asking their acquiescence to test their products and to be present to witness the tests at UL in Chicago. This option was also rejected by the contractors for obvious reasons.

UL finally stated that further testing of materials in MRCA's possession would be fruitless inasmuch as if they had (and did) fail in the testing laboratories utilized in previous tests, they would undoubtedly fail in the UL lab as well.

At the conclusion of the meeting, all present with the exception of UL agreed to form a roofing ad hoc committee to further this research. UL indicated that they would participate provided their manufacturer clients would agree to them doing so.

At the December 2003 ASTM meetings, a new task group was established to further research and better define the calibration methods used in E-108. This effort is a direct result of our research.

It must be pointed out that roofing contractors face potential liability issues given that they regularly provide representations as to the fire ratings of the assemblies they install, and are often tied to those projects by the issuance of a performance bond. MRCA bears no manufacturer ill will. It is, however, the history of this organization to aggressively investigate the products that our members install.

During this difficult time MRCA has endured both criticism from various constituents within the industry as well as financial repercussions because of our position

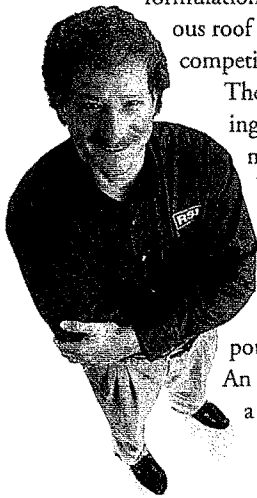
with respect to these matters. MRCA has not responded in kind, nor do we intend to do so. It is our desire to work cooperatively with all parties affected for the betterment of the roofing industry. We look forward to progressing further with all those who affirmed that same purpose in Chicago on November 13th.

MRCA not only affirms, but congratulates Dr. Dupuis for his excellent work over the last six years on this ongoing program, and further for his decades of untiring service to the roofing industry. We also wish to thank and congratulate other roofing organizations and MRCA affiliates for their financial support of this important industry research. Finally, MRCA honors its forward-thinking members, its affiliated participants and itself, as a whole, for making the ongoing commitment to serve roofing contractors throughout the country through the aggressive pursuit of quality in all aspects of the industry.

TPO problems require a closer look

The recent pulling of a new thermoplastic polyolefin (TPO) single-ply membrane from the roofing market should serve as a caution sign for both manufacturers and contractors who continue to produce and use these products.

It's true that the TPO that was recently discontinued was an ambitious product featuring greater flexibility and the ability to weld easier in colder temperatures. In reality, the product proved too time-consuming to weld in the field. At the same time, manufacturers of mainstream TPOs with longer track records may be continuing to change their formulations and ingredients to cope with various roof design challenges and to remain competitive in a cut-throat market.



The fact is that all of us have a lot riding on the future performance of TPO membranes. Roofing manufacturers bear a significant financial responsibility for their long-term warranties. Roofing contractors have their reputations to protect, and a major failure on a large job has the potential to ruin a smaller company. An even RSI has something to lose, with a significant portion of its advertising revenues coming in from TPO membrane suppliers.

The National Roofing Contractors Association (NRCA) has embarked on a program to monitor and then report on compound and formulation changes in TPOs purchased on a regular basis in the open market. The results will eventually be made available to NRCA members. However, the interpretation of these results will require some care, and certainly some guidance, from NRCA's technical department.

The recent TPO membrane cancellation is not the first time that problems with these systems have been experienced in the field. Difficulties with black TPO membranes have also been reported, especially when they lack U.V. stabilizers

and fire retardants. Experience to date with fully adhered TPO membranes also shouts "caution," particularly with black sheets. With a higher thermal expansion/contraction and greater stiffness than other thermoplastics, fully adhered TPOs *theoretically* run the risk of delamination or insulation facer peel. The quality of the adhesive bond to TPO membranes has also been questioned, but this issue has been addressed with new adhesive formulations.

Questions have also been raised about the use of 12-foot-wide TPO sheets fastened six inches on center. The three-dimensional forces endured by a TPO membrane at the point of mechanical attachment requires great strength and resistance to oscillating stress. The latest Factory Mutual wind uplift testing says this system has what it takes to survive. But some in the industry are asking: For how long?

The lack of a long track record for TPOs is the most common criticism thrown out by other single-ply roofing competitors. Most TPO suppliers have less than 10 years of experience manufacturing their products. Suppliers in Europe have greater experience, but their membranes are different. For one thing, average thickness is about 60 mils (no product is sold at less than 48 mils) compared to 31-45 mils of polymer in roof membranes sold in North America.

The point here is not to trash TPO. Single plies like EPDM have had teething problems (neoprene adhesives, shrinkage), and unreinforced PVCs were a nightmare. Contractors just need to keep in close touch with TPO suppliers and remember that each product welds differently. Manufacturers, on the other hand, need to show some discipline. A strategy of "how low can we go" in terms of price and quality is a recipe for disaster. **RSI**

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**Readers:
We Want to
Hear from You**

Mike Russo
Editor

7500 Old Oak Boulevard
Cleveland, OH 44130

440-891-2704

440-891-2733

**mrusso@
advanstar.com**

Teresa O'Dea
Senior Editor

One Park Ave.—2nd Floor
New York, NY 10016-5802

212-951-6636

212-951-6666

**todea@
advanstar.com**

Dick Fricklas
Contributing Editor

8260 E. Geddes Avenue
Englewood, CO 80112

303-773-6014

303-773-6739

**RUFAS96@
aol.com**

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Thermoplastic Polyolefin Roofing Membranes

By Ralph M. Paroli, Karen K.Y. Liu and Terrance R. Simmons

Thermoplastic polyolefins are a new generation of single-ply roofing systems. This Update reviews their characteristics and performance to date and clarifies some misunderstandings related to terminology.

A typical low-slope roofing system consists of three components: a structural deck, a thermal insulation barrier and a waterproofing membrane, which consists of reinforcing fibres or fabric sandwiched between two sheets of flexible matrix. The matrix material is either asphalt- or polymer-based. In single-ply membranes the matrix is made of flexible polymer. The reinforcement provides dimensional stability for the membrane as well as strength to resist stresses in service. It is generally made of chopped short glass fibre strands packed in mat, or continuous polyester fibre arranged in a grid or in a non-woven mat.

There are essentially two classes of polymer-based roofing membranes: thermosets (TS) and thermoplastics (TP). Thermoplastics soften when heated (this process is reversible) but thermosets do not. Thermosets include the commonly used ethylene propylene diene monomer [also known as ethylene propylene diene terpolymer] (EPDM), while thermoplastics encompass a wider variety of roofing membranes, including thermoplastic polyolefins (TPOs).

All thermoplastic roofing membranes, share certain characteristics, e.g., seaming can be done by heat welding. However, for the most part, they have very different chemical, physical and mechanical properties. It is impossible to explain these differences here, but there are different ASTM material-based standards for various TP products. To avoid confusion, one should not just label all of these products simply as TP products. TPOs differ from other TPs in several respects, and thus must be handled and applied differently.

Definition of TPO

Defining thermoplastic polyolefin is difficult. "Thermoplastic" is a generic term in polymer science; it encompasses a class of polymer that, as mentioned above, softens when heated in a reversible process. The term "olefin" is even more generic, being an old chemical name for any molecule containing carbon-carbon double bonds (the modern name for this family of molecules is alkenes). Any polymer formed by chemically linking up many olefin

molecules is termed "polyolefin." According to the latest draft ASTM standard for TPOs, the composition is very non-specific. The standard states that TPOs must contain more than 95% by mass of TPO polymer. The polymer itself is not defined within the standard, which states only that the sheet shall contain the "appropriate" polymers. Because of this loose definition, there is an endless list of chemicals that would fall under this standard (e.g., polyethylene, polypropylene, and isobutylene, as well as their derivatives). Ideally, manufacturers would specify the exact polymer in terms of marketing and labelling. There are a few published papers that attempt to explain the different types of TPOs [1-4]. One point is clear, however: unlike plasticizers thermoplastic membranes, TPOs do not contain plasticizers (small molecules added during compounding to increase the flexibility of the product. Therefore, the problem of plasticizer loss associated with some plasticized membranes is eliminated.

Confusion in the Market Place

TPO roofing membranes have been in service in Europe for approximately ten years. The first appearance of a "TPO-type" roofing product in the United States was around 1987. As yet, little is known about their durability. The confusion associated with TPOs comes from both the chemical terminology of the product marketing. The latter has promoted mainly the EPDM-like characteristics of TPOs, i.e., it being like rubber with the added benefits of welded seams (which EPDMs do not have). Also promoted has been the chemical resistance attributed to the olefin component of the polymers. Unfortunately, some confusion has occurred, especially regarding the use of the term thermoplastic (TP). It is important to remember that TPOs are thermoplastic (i.e., TPs) but only some TPs are TPOs.

Benefits of TPOs

In general, TPO membranes are being marketed as a product that combines the properties of EPDM and PVC, without the associated drawbacks that the latter two materials have. In other words, they are supposed to be a UV-resistant and as heat-resistant as EPDM, and as heat-weldable as PVC. The following

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benefits and characteristics have been reported for TPOs [1-3]:

Environmentally friendly and recyclables, Seams can be heat welded, Available in many colors, Resistant to heat and UV degradation, Resistant to many chemicals, Good cold-temperature flexibility, No external plasticizers added.

Performance of TPOs

TPO membranes are lighter in weight and easier to handle than the other thermoplastic membranes. But, while flexible, they have a rather rigid feel: they tend to hold their shape, and do not relax quickly. Contractors appear to be adjusting slowly to them and some say they are not "contractor-friendly." Their comments about TPO's include the following:

- Hot-air welded seams are easy and clean;
- Costs are lower than for other hot-airwelded membranes;
- Mechanically fastened systems (as opposed to loose laid or fully adhered systems) work well in recover applications without adding extra load;
- Non-reinforced flashing membranes are easy to form for detailing;
- Noticeable changes in colour and texture occur over time;
- Membranes respond dramatically (expansion and contraction) to temperature changes;
- Cold welds (i.e., welds at temperatures that are not hot enough) occur frequently; the start and stop positions of the robotic welder are especially critical, as are the positions of t-seams;
- Narrow welding window exists between cold welds and scorch/burn-through (i.e., welds at temperatures that are too hot);
- Failure of substrate bonding adhesive is common (i.e., not sticking to membrane);
- Membranes sometimes require solvent wipe (to clean or prime) before welding;
- Re-welding membranes (in repair) is problematic after exposure to sun;
- Black membranes are more difficult to weld than white ones.

Summary

Because of the chemical terminology involved, the non-specific chemical composition of the polymer and the marketing focus of manufacturers, there is much confu-

sion about TPO roofing membranes.

If the ASTM task group developing the TPO standard insists on using the term "olefin" in the standards name, then it should consider using the name "Flexible or Thermoplastic Polyolefin" in the title, as this would be in line with the terminology used in Europe (i.e., flexible polyolefin, FPO). Furthermore, manufacturers should consider clearly stating whether their product is a polypropylene- or polyethylene-based system, to minimize possible confusion.
