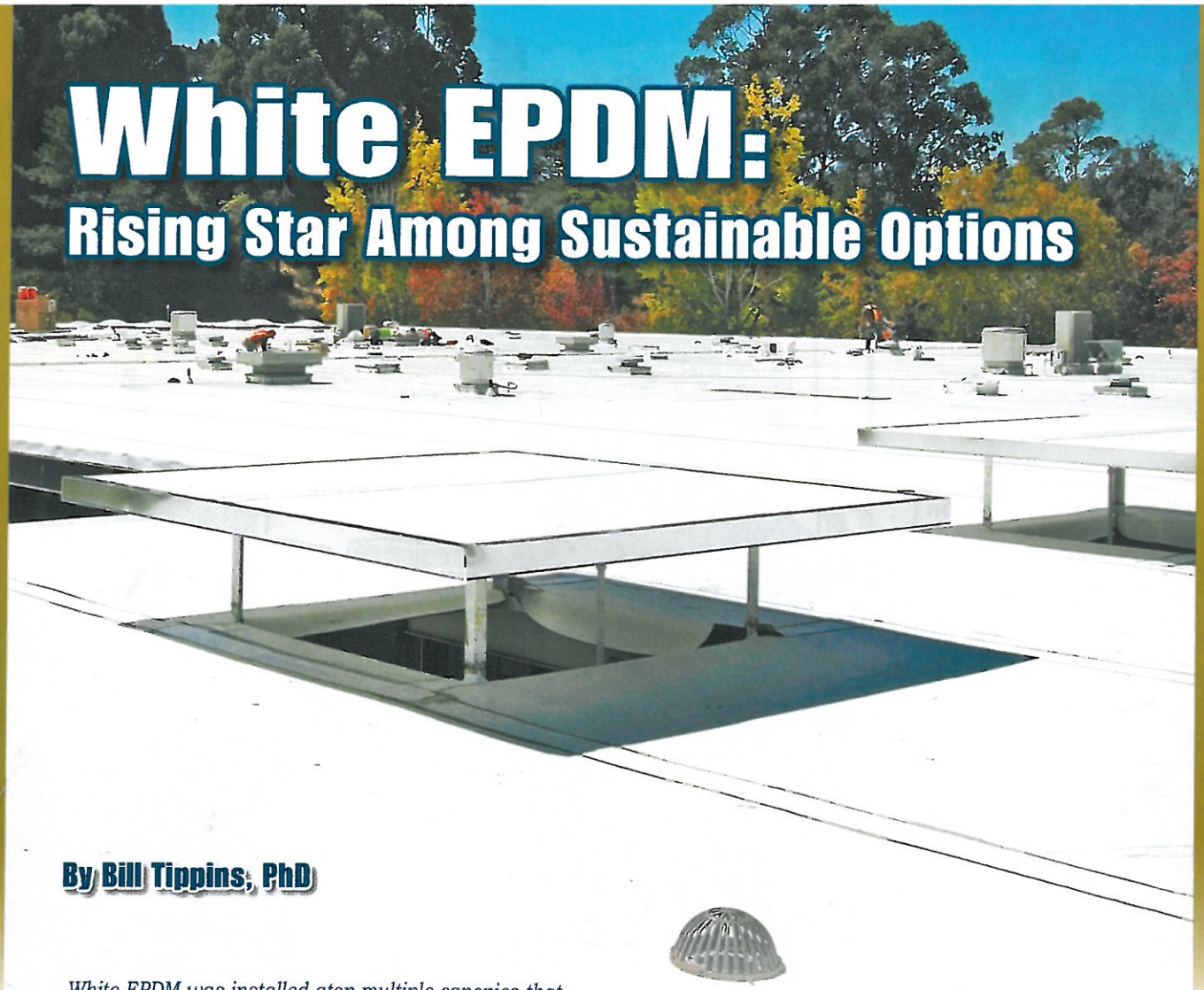
White EPDM:
Rising Star Among Sustainable Options



By Bill Tippins, PhD

White EPDM was installed atop multiple canopies that covered breezeways at Aragon High School in San Mateo, CA.

With each passing year, the green building movement continues to escalate within the commercial construction market, putting energy-efficient roofing technologies at the forefront. Much of the discussion about sustainable roofing options, however, has focused on photovoltaic (PV) solar panels, daylighting systems, vegetative or garden roofs, as well as white or light-colored reflective roof membranes such as thermoplastic polyolefins (TPO) and polyvinyl chloride (PVC) for low-slope applications.

As a result, it may be easy to overlook the positive environmental impact being made by ethylene propylene diene terpolymer (EPDM) roof membranes. With billions of square feet installed across all climate zones, 40+ years of proven field experience, and a history of research that supports its energy-saving characteristics and overall value, EPDM must be part of the conversation.

From energy efficiency to aesthetics, membrane color does and should play a role in many roofing decisions. However, from a sustainability perspective, consideration must also be given to the roofing materials' durability, life-cycle assessment (LCA), and overall environmental impact. In that regard, EPDM roofing systems – both black and white formulations – have proven they can provide a strong, energy-efficient option. In fact, white EPDM membranes have been among the fastest-growing segments of the single-ply roofing market in recent years due to the increased focus on sustainability.

In addition to the growing emphasis on environmentally responsible building practices, other forces are making LCA requirements more likely in the future. Specifically, these include more sophisticated criteria for financing of construction projects and increasing governmental regulation within the public construction sector.

EPDM – PROVEN HISTORY

According to the EPDM Roofing Association (ERA), EPDM rubber roofing membrane accounts for nearly 1 billion sq. ft. of new roof coverings in the United States annually. Despite being in use for more than four decades, EPDM has seen its most significant growth in the last 25 years. Today, there are well over 500,000 warranted roof installations totaling more than 20 billion sq. ft. of EPDM membrane in place nationwide.

Recent studies conducted on behalf of ERA firmly validate the long-term performance attributes of EPDM roof systems. White EPDM, in particular, has demonstrated that its combination of high reflectivity

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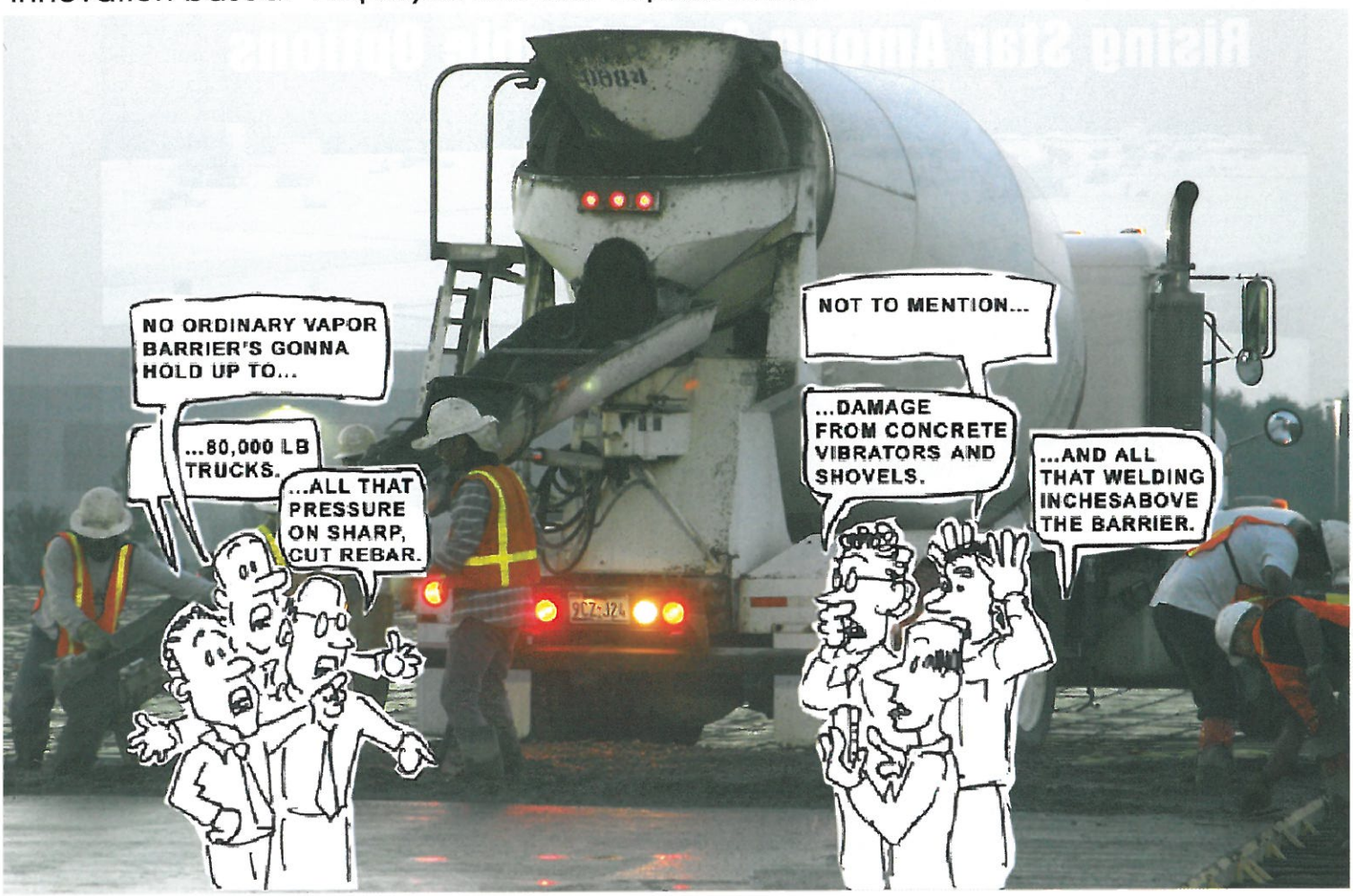

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			Initial	After 3 yrs.	Initial	After 3 yrs.	Initial	After 3 yrs.
0608-0027	Firestone Building Products	EcoWhite EPDM	0.80	0.72	0.84	0.86	99	88
0612-0009	Tremco	Premium FR T24 Modified Bitumen	0.75	0.63	0.86	0.88	92	76
0628-0003	Carlisle SynTec	Sure-White EPDM	0.76	0.64	0.90	0.87	94	77
0676-0040	GAF	EverGuard PVC White	0.87	0.61	0.95	0.86	111	72
0670-0015	Mule-Hide Products	PVC Bright White	0.87	0.61	0.95	0.86	111	72
0742-0001	Siplast, Inc.	Veral Polar White Spectra Mod Bit	0.62	0.60	0.87	0.81	74	69

Figure 2 – Source: Cool Roof Rating Council Directory of Rated Products (coolroofs.org), updated Nov. 14, 2011.

than 78 for low-slope roof systems.

As shown in *Figure 2*, the Cool Roof Rating Council's online directory of rated products lists solar reflectivity, thermal emittance, and SRI (initial and after three years) for a variety of single-ply thermoset and thermoplastic membranes, as well as modified-bitumen products. Given the increased attention being paid by building owners and roofing professionals to cost-efficient, sustainable roofing solutions, aged reflectivity has become a critically important data point to consider. Although the USGBC has incorporated LCA of building materials in its LEED® rating system, some industry experts believe there is an overemphasis on environmental benefits without equal concern for durability.

Additionally, as a rubber-based material, white EPDM roofing systems are more flexible than thermoplastic membranes, allowing for year-round application. In cooler temperatures, fully adhered EPDM membranes remain pliable and easy to install, while thermoplastics tend to stiffen and are often more difficult to install, particularly on irregular substrates and transition changes around vertical walls, parapets, and curbs.

White EPDM roofing membranes are ideal for UL- and FM-rated systems, while exceeding ASTM D4637 standards. They are well suited for new construction and reroofing applications, and they can be installed over steel, concrete, wood, and other common deck types.

Figure 3 provides a comparison of key physical properties between white and black EPDM. Conducted at Firestone Building Products' research laboratory in Indianapolis, IN, the analysis shows the many similarities between the two membranes across key performance criteria. Most notably for white EPDM is the fact that its performance meets or exceeds that of black EPDM for initial and heat-aged tensile strength, initial and heat-aged tear strength, and ultraviolet (UV) resistance.

and inherent physical characteristics (e.g., fatigue resistance, low-temperature flexibility, thermal-shock durability, etc.) are key considerations when specifying sustainable roof systems.

One study conducted by Tulsa, Oklahoma-based GreenTeam, Inc., a strategic environmental consulting firm specializing in building industry issues, examined LCA data for a variety of membrane types. Included in the study were EPDM (black and white), TPO (gray and white), PVC (gray and white), and SBS-modified bitumen, as well as several attachment methods. A summary of findings was published in the December 2010 *Interface* article "New Life Cycle Data for EPDM: Outstanding Performance in Reducing Environmental Impact," by Thomas Hutchinson, RRC, FRCI, AIA, and principal in the Hutchinson Design Group, Ltd., Barrington, IL.

Among the more noteworthy findings of the comprehensive study was that EPDM performed significantly better than comparable roof assemblies based on its long-term environmental impact. The research, which was based on the most current data available from industry and public sources, also reported that the environmental impact of EPDM is lower than previously thought.

As illustrated in *Figure 1*, the role of service life varies substantially by membrane type, while attachment method plays a less significant role in determining overall environmental impact. The study examined energy-related categories, such as global warming potential (GWP) as measured by kilograms of CO_2-equivalents, because they offer the most relevance. Among the membrane types, fully adhered, nonreinforced, 60-mil white EPDM was found to have the lowest GWP (22.4 kg/m^2), while a 140-mil, "unsurfaced"[1] SBS exhibited the highest (81.8 kg/m^2). Among the other materials studied, reinforced, 60-mil, white PVC produced GWPs of 67.8 kg/m^2 (mechanically attached) and 73.1 kg/m^2 (fully adhered), more than three times that of white EPDM. In fact, three of the four lowest GWP measurements were from EPDM systems.

Additionally, the GreenTeam determined the number of years each system would have to perform to negate the GWP created during its manufacture and installation. Using a service life of 15 years for the system with the lowest GWP – fully adhered, white EPDM – as the benchmark to compare all tested systems, the GreenTeam established that EPDM systems had the lowest service life equivalencies overall. White TPO membranes ranged from 20 to 20.7 years, white PVC systems were 45.4 and 49 years, which means a white PVC roof must stay in place three times longer than a white EPDM roof to achieve equivalency with respect to GWP.

System	Membrane	Attachment	Carbon Footprint (GWP) (kg CO^2 eq./ m^2)	Minimum Service Life to Achieve Equivalency (Years)[1]
EPDM	60-mil nonreinforced black	Ballasted	28.3	19.0
		Fully adhered	29.6	19.8
	60-mil reinforced black	Mech. attached	28.7	19.2
	60-mil nonreinforced white	**Fully adhered**	**22.4**	**15.0**
TPO	60-mil reinforced white	Fully adhered	30.9	20.7
		Mech. attached	29.8	20.0
	60-mil reinforced gray	Fully adhered	30.5	20.4
		Mech. attached	29.4	19.7
PVC	60-mil reinforced white	Fully adhered	73.1	49.0
		Mech. attached	67.8	45.4
	60-mil reinforced gray	Fully adhered	58.6	39.2
		Mech. attached	54.2	36.3
SBS	140-mil "unsurfaced"[2]	Fully adhered	81.8	54.8

(1) Using a conservative 15-year service life for the lowest-impact system (fully adhered white EPDM)
(2) "Unsurfaced" refers to the GWP impact relative to the modified bituminous sheet alone. No consideration is given to additional GWP impact for coatings, foils, or ceramic granule facings.

Figure 1 – Minimum service life to distribute GWP equally. Source: "Life Cycle Inventory and Assessment of Selected Low-Slope Roofing Systems in North America," TEGNOS Research, Inc., 2009.

ROLE OF ROOF DURABILITY

In a white paper titled "Sustainable Buildings: Addressing Long-Term Building Envelope Durability," Dr. James Hoff, research director for the Center for Environmental Innovation in Roofing (CEIR), noted several industry researchers have expressed concern that today's green rating systems may not emphasize product durability enough.

Specifically, Hoff cited Jamie McKay, a LEED® Accredited Professional, who said, "The majority of green-building assessment systems focus on the design of the constructed building, with little focus on the effect of the building system's life during operation. This tendency has resulted in a failure of many rating systems to properly consider durability, life cycle cost, and the effects of premature building envelope failures."

Compared to traditional life cycle cost analysis, LCA is a better measure of a roofing material's cradle-to-grave impact and more accurately reflects its long-term economic and environmental value. As such, system durability is a critically important factor in sustainable roofing decisions. While this applies to all building types, it is especially relevant for applications where long-term building ownership is concerned, such as school districts and healthcare facilities.

WHITE EPDM

In use since 1987, white EPDM features similar physical properties and benefits of black EPDM, yet it provides a highly reflective solution to coated membranes and thermoplastics. With its high solar reflectance index value, the bilaminate, white-on-black cured membrane can help achieve points in the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED®) Green Building Rating System, specifically Section SS 7.2 regarding the heat island effect, which requires the membrane to have a solar reflectance index (SRI) value of greater

Black vs. White EPDM				
Physical Properties	Test Method (per ASTM D4637)	ASTM Minimums	Typical Values Black EPDM (0.060")	Typical Values White EPDM (0.060")
Thickness, min. sheet overall	ASTM D412	0.054 in	0.059 in	0.056"
Tensile strength, min.	ASTM D412 (Die C)	1305 psi	1415 psi	1360 psi
Elongation, ultimate, min.	ASTM D412 (Die C)	300%	492%	468%
Tensile set, max.	ASTM D412 (Die C)	10%	2.58%	2.10%
Tear resistance, min.	ASTM D624 (Die C)	150 lbf/in	205 lbf/in	234 lbf/in
Brittleness point, max.	ASTM D2137	-49°F (-45°C)	-63°F (-53°C)	-69°F (-56°C)
Ozone resistance, no cracks	ASTM D1149	Pass	Pass	Pass
Water absorption, max., mass %	ASTM D471	+8, -2%	1.54%	2.50%
Factory seam strength, min.	ASTM D816 (50 lbf/in)	50 lbf/in or sheet failure	Sheet failure	Sheet failure
After Heat Aging (4000 hrs.)	ASTM D 573			
Tensile strength, min.	ASTM D 412 (Die C)	1205 psi	1477 psi	1317psi
Elongation, ultimate, min.	ASTM D412 (Die C)	200%	302%	325%
Tear resistance, min.	ASTM D624 (Die C)	125 lbf/in	176 lbf/in	240 lbf/in
Linear dimensional change, max.	ASTM D1204	±1.0%	-0.14%	-0.50%
Weather resistance:				
Visual inspection	ASTM D518	Pass	Pass	Pass
PRFSE, min.	ASTM D518	30%	64%	51%
Elongation, ultimate, min.	ASTM D412 (Die C)	200%	255%	277%
Ultraviolet weather resistance (Xenon-arc weathering)	ASTM G155	Pass (4000 hrs)	Pass	Pass

Figure 3 – Black vs. white EPDM. Source: Firestone Building Products, laboratory testing facility, Indianapolis, IN, 2007.

FOUNDATION FOR SOLAR PANELS

the schools as possible (Photo 1). Among the initial phases of the reroof project, more than 2,500 PV panels were installed atop three schools: Aragon, Mills, and Hillsdale. The facilities combined for more than 420,000 sq. ft. of roofing surface and required approximately 6,000 stanchions to

factors led to the specification of a fully adhered, 90-mil Firestone RubberGard™ EcoWhite™ EPDM membrane.

With BEST Contracting Services of Hayward, CA, serving as installation con-

Photo 1 – White EPDM roofing membrane serves as a high-performance foundation on a multifacility reroof project for the San Mateo Union High School District that featured more than 2,500 photovoltaic panels installed atop three California high schools.

tractor, the white EPDM membrane was adhered to a high-density cover board that was mechanically attached through the existing SBS modified-bitumen system and into the steel deck. After the white EPDM membrane was in place, BEST crews prepared the stanchions to support the PV panels using customized target patches and boots supplied by Firestone to help expedite the installation process across three separate buildings (*Photo 2*). Upon completion and inspection, a 30-year warranty was issued by Firestone, ensuring the roofing system was protected throughout the life expectancy of the PV system.

According to QKA architect Nick Stephenson, "In addition to the benefits of white EPDM with respect to solar heat gain, the school district needed a high-quality roof that could handle literally thousands of penetrations required for the PV support stanchions. White EPDM was a perfect fit."

At a ceremony dedicating the San Mateo Union High School District's solar-powered roofing system, which includes the new PV

Photo 2 – Customized white EPDM target patches and boots used around the stanchions to support the PV panels helped expedite the installation process.

panels installed over white EPDM membrane at the three schools, Tom Torlakson, California's state superintendent of public instruction, said, "This project at Aragon High School serves as an excellent model for future California school construction projects. Students deserve to have school environments that embrace the 21st century and are not relics of the past. The investment in renewable projects like this one shows how we can modernize our schools while creating jobs, saving money, protecting the environment, and generating thousands of teachable moments for students."

As the conversation about choosing the right roofing materials to help reduce overall energy costs continues, the environmental benefits of EPDM play an equally significant role in determining what roofing system is best suited for an individual building. White EPDM, in particular, possesses the same physical traits as its black counterpart while providing a highly reflective alternative to thermoplastics and coated membranes.

FOOTNOTES

1. "Unsurfaced" refers to the GWP impact relative to the modified-bituminous sheet alone. No consideration is given to additional GWP impact for coatings, foils, or ceramic granule facings.

REFERENCES

T.W. Hutchinson, "New Life Cycle Data for EPDM: Outstanding Performance in Reducing Environmental Impact," *Interface*, December 2010.

J.L. Hoff, "Sustainable Buildings: Addressing Long-Term Building Envelope Durability," *Proceedings of the RCI 24th International Convention and Trade Show*, March 12-17, 2009.

Bill Tippins, PhD

Bill Tippins, PhD, EPDM product manager for Firestone Building Products, LLC, is responsible for researching market needs and directing planning and development for the EPDM market. With more than 20 years of industry experience, Tippins' most recent position within Firestone Specialty Products includes developing new commercial and industrial markets for the company's EPDM, TPO, and polypropylene membranes. Previously, Tippins was the geomembrane product manager at GenFlex Roofing Systems, where he was responsible for the development, marketing, and sales of its geomembranes. Tippins has a doctorate in synthetic organic chemistry from the University of Georgia and a master's in business administration from the University of Houston. He is also a member of the Technical Committee for the EPDM Roofing Association.

Barb Thomas identified the roofing products she'll need, modified the construction details, identified the green attributes and produced LEED® documentation for her project.

And that was just on her coffee break.

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