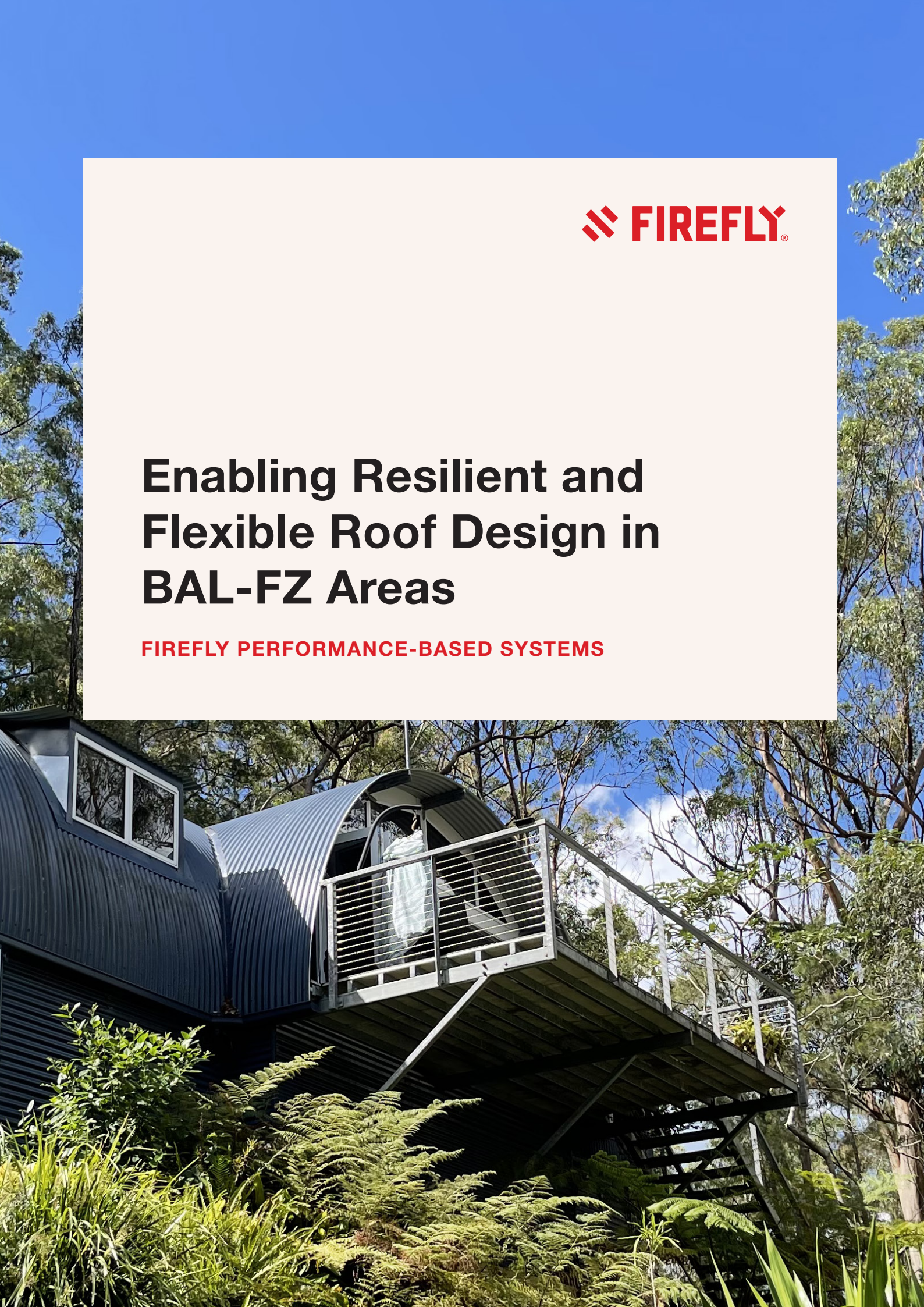
FIREFLY®

Enabling Resilient and Flexible Roof Design in BAL-FZ Areas

FIREFLY PERFORMANCE-BASED SYSTEMS



INTRODUCTION:
BUSHFIRE-RESILIENT DESIGN IN A CHANGING CLIMATE

Australia's bushfire risk is not static. Climate change impacts including rising temperatures, prolonged droughts, and more episodes of extreme fire weather has already demonstrably increased the frequency, intensity, and duration of bushfires. Studies attribute significant portions of recent catastrophic seasons (such as Black Summer 2019–2020) to anthropogenic warming, with projections indicating further escalation under future warming scenarios. Extreme fire weather days have become more common, particularly in southern and eastern Australia, extending fire seasons and compressing windows for safe property development and maintenance.

This reality intersects with pressing societal needs: providing affordable housing stock in a country with growing population pressures and limited supply. Many desirable development areas sit at the urban-bush interface, where land is often more attainable yet carries elevated risk. At the same time, there is increasing demand for homes that offer not just immediate safety but long-term durability; buildings that withstand not only bushfire events but decades of variable climate conditions, reducing maintenance costs, material replacement cycles, and overall lifecycle environmental impact.

For architects and designers, this presents a dual challenge and opportunity. Bushfire standards like AS 3959 are not merely regulatory hurdles; they are frameworks for creating genuinely resilient architecture. Bushfire Attack Level – Flame Zone (BAL-FZ), the most stringent category, need not be feared. Instead, it can be embraced as a unique design catalyst in usually spectacular locations such as ridgelines, forested hillsides, coastal hinterlands, and national park adjacencies that offer breathtaking views, natural amenity, and lifestyle value. Performance-based solutions allow designers to harmonise protection with site-responsive, beautiful, and functional outcomes that enhance property resilience and desirability.

BAL-FZ AS A UNIQUE DESIGN OPPORTUNITY

Far from a limitation, BAL-FZ sites often occupy some of Australia's most visually and experientially-rich landscapes. These locations reward thoughtful design: sweeping views, immersion in nature, and elevated environmental performance. Architects who master BAL-FZ principles can deliver homes that celebrate their settings rather than retreating from them.

Key educational considerations for designers include early integration of bushfire planning into the conceptual phase. Understanding ember attack, radiant heat, and flame contact mechanisms informs holistic decisions – from siting and landscaping (defensible space) to material selection and detailing. Performance-based pathways, as permitted under the National Construction Code (NCC), reward innovation over rigid prescription, enabling optimised outcomes for cost, aesthetics, and longevity.

Affordability is enhanced when systems reduce structural over-design, material waste, and installation complexity. Longevity stems from addressing interconnected performance criteria: fire resistance paired with hygrothermal management (moisture and thermal control) to prevent degradation, condensation-related damage, and mould – issues that plague many sealed, high-compliance buildings over time.

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THE CHALLENGES OF BAL-FZ ROOF DESIGN

Roofs represent one of the most complex and critical elements in BAL-FZ construction. They must provide continuous, gap-free protection (no unprotected openings greater than 2 mm) against embers, heat, and flames while managing wind uplift, water ingress, condensation, and everyday environmental loads.

Core complexities include:

- **Complex Geometries:** Curved roofs, hips, valleys, rakes, eaves, and irregular forms that respond to site topography or architectural vision create multiple junctions prone to failure if not detailed meticulously.
- **Service Penetrations:** Flues (AS 2918 compliant), vents, solar installations, plumbing, electrical conduits, and skylights introduce vulnerabilities that require tested, sealed solutions without compromising functionality or airflow.
- **Balancing Fire Performance with Building Science:** Strict sealing for ember resistance can trap moisture, leading to interstitial condensation, timber rot, reduced insulation efficacy, and premature material failure, which is particularly problematic in Australia's humid or variable climates.
- **Structural and Practical Constraints:** Heavy protective systems increase dead loads, demanding stronger (and costlier) framing, while complicating installation on steep or remote sites.
- **Aesthetic and Functional Intent:** Clients seek light-filled, energy-efficient, low-maintenance homes that integrate with their environments. Overly prescriptive approaches can force simplified forms that undermine these goals.

Educating designers on these interdependencies is vital. Suboptimal roof detailing is a common point of failure or cost overrun in bushfire projects. Early collaboration with bushfire consultants, structural engineers, and specialist suppliers ensures integrated solutions that enhance rather than constrain the overall design.

LIMITATIONS OF CONVENTIONAL SOLUTIONS

Conventional BAL-FZ roof protections are typically heavy fire-rated boards (e.g., fibre cement or specialist panels) or DtS details from AS 3959, and provide baseline compliance but often at significant trade-offs:

- **Weight and Structural Impact:** These systems add substantial loads, necessitating upgraded rafters, beams, and fixings. This inflates costs, embodied carbon, and construction complexity, hindering affordability goals.
- **Rigidity on Complex Forms:** Boards are difficult to adapt to curves or intricate geometries, leading to labour-intensive cutting, fitting, potential gaps, and compromised continuity. Ventilation is frequently restricted.
- **Limited Penetrations and Buildability:** Many systems offer no tested options for services, forcing design compromises or expensive custom engineering. On-site fabrication generates waste and error risks.
- **Moisture and Longevity Issues:** Reduced vapour permeability can exacerbate condensation, shortening building lifespan and increasing maintenance burdens which is contrary to goals of durable, affordable housing.
- **Testing and Applicability:** Not all conventional assemblies undergo full-scale AS 1530.8.2 testing for complete systems, including junctions and penetrations, leading to reliance on component-level assurances or judgements that may not fully replicate real bushfire conditions.

These limitations can drive up project costs, extend timelines, and force aesthetic or functional compromises that reduce the appeal and long-term value of homes in premium bushfire-prone locations.

FIREFLY BAL-FZ SYSTEMS: A SMARTER, PERFORMANCE-BASED APPROACH

FIREFLY BAL-FZ systems from TBA Firefly shift the paradigm with a lightweight, flexible fabric solution. The core material, FIREFLY Plus 60, is installed as a continuous insulating protective layer beneath the external roof covering. Fully tested to AS 1530.8.2 for BAL-FZ performance, it safeguards roofs, eaves, fascias, gutters, valleys, and critical junctions while enabling design flexibility.

This fabric-based approach advances a new way of thinking: protection as an integrated, adaptive membrane rather than a rigid barrier. It supports architects in delivering resilient outcomes that are practical, cost-effective, and future-proof.

Key Advantages for Architects and Designers

1. **Adaptability to Complex Geometries** The fabric drapes and conforms to curves, hips, valleys, and non-linear forms, maintaining fire-rated continuity. This preserves ambitious architectural intent – such as sweeping roofs that engage with dramatic landscapes, while ensuring compliance.
2. **Tested Penetrations** Among the few systems offering detailed, tested solutions for flues, vents, pipes, solar mounts, and services. This reduces design constraints and supports modern, functional homes with renewable energy integration.
3. **Lightweight Construction (≈80% Lighter)** Dramatically reduces structural demands, enabling lighter, more affordable framing. Lower transport emissions, easier handling, and faster installation improve buildability and project economics – key for scaling resilient housing stock.
4. **Ventilated and Vapour-Permeable Solutions** Seamless integration with vapour-permeable membranes supports proper roof cavity ventilation. This mitigates condensation, enhances durability of timber and insulation, improves energy efficiency, and contributes to healthier indoor environments which is critical for long-term building performance.
5. **Superior Buildability, Cost Efficiency, and Longevity** Roll-form application minimises waste, simplifies detailing, and reduces on-site errors. The resulting assemblies are not only fire-resilient but also better equipped to handle Australia's climate variability, extending service life and lowering whole-of-life costs.

PROVEN PERFORMANCE IN PRACTICE

Real-world applications of FIREFLY BAL-FZ systems provide valuable lessons for architects and designers navigating similar constraints.

Callignee 2 (Victoria) – The Original Bushfire House

Callignee 2, featured in the inaugural episode of Grand Designs Australia, stands as a landmark project in post-disaster resilient design. Owner-builder Chris Clarke's original home on a five-acre bushland site in Gippsland was destroyed just days after completion during the 2009 Black Saturday fires. In its place rose Callignee 2 - a smaller, highly conceptual, off-grid eco-retreat rebuilt using the surviving concrete slab and steel frame elements.

The design embraced sustainability, reuse, and extreme fire resilience in a BAL-FZ location. FIREFLY Plus 60 was installed as a continuous protective layer in the roof space, providing the necessary insulation and integrity under AS 1530.8.2 testing. This allowed for a complex roof form that incorporated a substantial green roof element planted with local and indigenous species, contributing to thermal performance and biodiversity while maintaining full flame zone protection.

The lightweight fabric system was crucial for the project's curved and irregular geometries, enabling seamless integration around junctions, eaves, and penetrations without the weight penalties or rigidity of traditional boards. Combined with Cor-Ten weathering steel cladding, recycled materials (including fire-scarred timbers from the original build), and non-toxic, low-maintenance finishes, the home achieved outstanding durability. It has since become a symbol of regeneration, winning multiple design awards and demonstrating that BAL-FZ compliance can coexist with architectural ambition and environmental stewardship. Architects note how the system supported the open-plan, light-filled interior volumes and the integration of a lap pool and loft spaces without compromising the defensive envelope.

The lesson of Grand Designs Australia "Bushfire House" (Callignee 2)

With the pioneering project highlighted above, the Grand Designs exposure brought national attention to performance-based BAL-FZ solutions. The roof design was particularly instructive: the flexible FIREFLY fabric conformed to the multifaceted roof profile, including areas dedicated to rooftop planting, while accommodating necessary service penetrations and ventilation strategies. This integration prevented the moisture-trapping issues common in heavily sealed conventional systems, supporting the home's long-term hygrothermal performance in a high-humidity bushland setting. The project illustrates how early adoption of tested fabric systems can unlock creative freedom – such as the dramatic rusty steel aesthetic that blends with the regenerating landscape, while delivering verifiable safety and reduced structural demands.

Custom NSW Residential Projects

In New South Wales, FIREFLY BAL-FZ systems have enabled numerous bespoke residential projects in high-risk bushfire zones, particularly in areas like the Blue Mountains, Hawkesbury, and coastal hinterlands. These custom homes often feature non-standard architectural forms – sweeping curves, extensive glazing, and complex valley/hip detailing – that respond to dramatic topography and views.

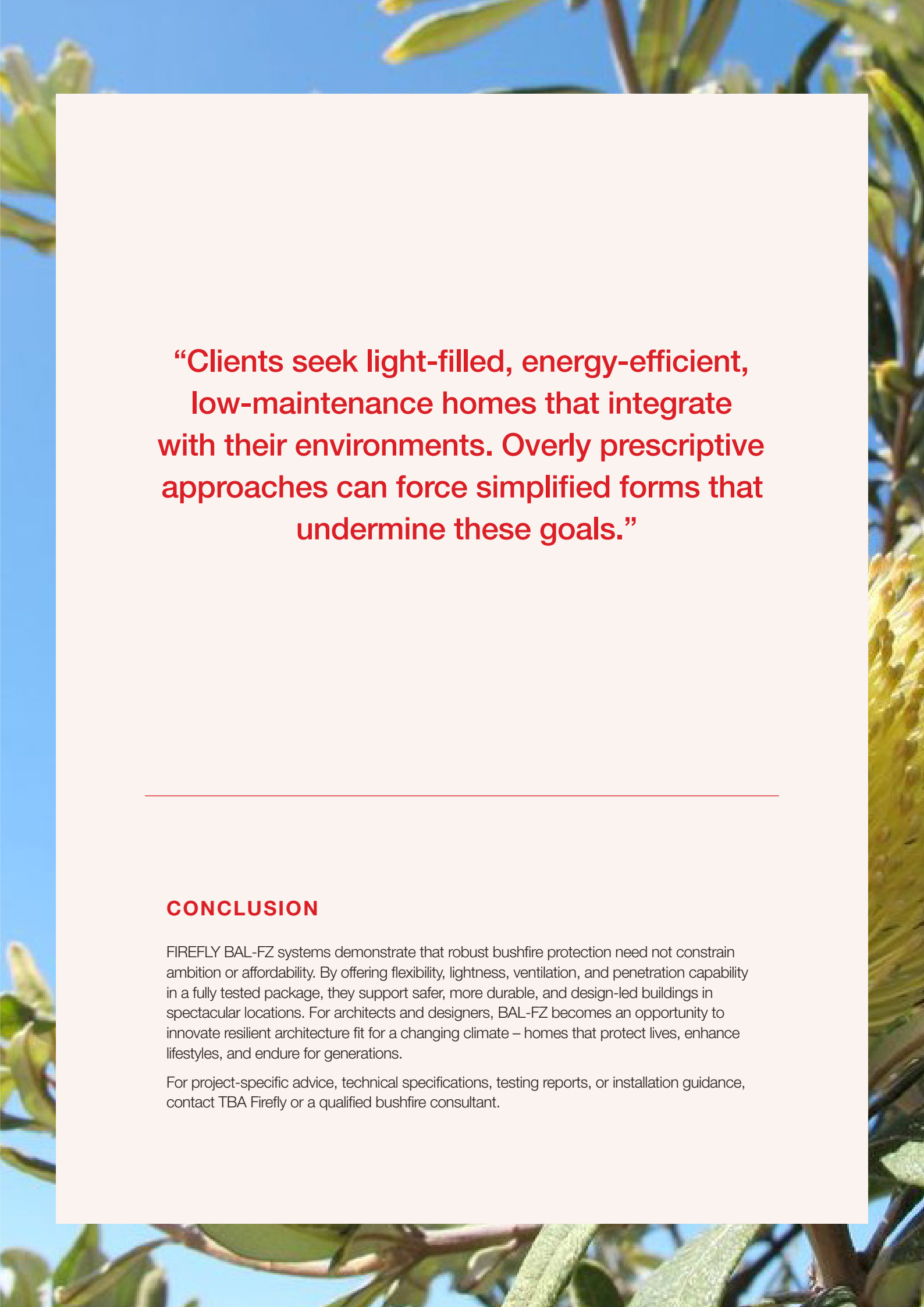
Designers have leveraged the system's tested penetration details for flues, solar arrays, and ventilation, allowing modern energy-efficient features without extensive custom engineering. In one notable series of projects, the lightweight fabric reduced framing requirements, contributing to more affordable construction costs while maintaining full compliance within 10 metres of vegetation. VapourSafe integration was key to addressing local climate challenges, ensuring condensation control in ventilated roof cavities and enhancing overall building longevity. Feedback from architects emphasises faster installation, minimal waste, and the ability to preserve client visions for light, airy, site-responsive homes that feel integrated into their spectacular natural settings rather than fortified against them. These projects collectively demonstrate scalable application for both premium custom builds and broader efforts to increase resilient housing stock.

These case studies highlight recurring themes: the value of flexible, tested systems in complex geometries; the synergy between fire protection and building science for durability; and the potential for BAL-FZ to inspire rather than restrict exceptional architecture.

DESIGNING FOR THE FUTURE: AFFORDABLE, LONG-LASTING HOMES IN HIGH-RISK ZONES

As bushfire risks grow, performance-based systems like FIREFLY empower the industry to deliver more affordable, resilient housing without sacrificing quality or ambition. Early collaboration with bushfire consultants, certifiers, and suppliers optimises approvals and outcomes. Designers should prioritise integrated solutions that address fire, moisture, thermal, and structural needs holistically.

Future advancements may include greater modularity, smart monitoring, and hybrid material innovations, further enhancing viability in expanding risk zones.



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CONCLUSION

FIREFLY BAL-FZ systems demonstrate that robust bushfire protection need not constrain ambition or affordability. By offering flexibility, lightness, ventilation, and penetration capability in a fully tested package, they support safer, more durable, and design-led buildings in spectacular locations. For architects and designers, BAL-FZ becomes an opportunity to innovate resilient architecture fit for a changing climate – homes that protect lives, enhance lifestyles, and endure for generations.

For project-specific advice, technical specifications, testing reports, or installation guidance, contact TBA Firefly or a qualified bushfire consultant.

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