

## HySafe Vertex Rapid-Relief Vent Panels



The Rhino Engineering Group is a leader in designing, fabricating, and installing advanced safety solutions across various high-risk industries. With a reputation for innovation and excellence, we have consistently delivered state-of-the-art technologies designed to enhance safety and operational efficiency.

The Rhino Engineering Group has developed and patented a new low-inertia, rapid-action explosion relief vent for use in the hydrogen economy, battery energy storage systems, and other sectors where protection from deflagration hazards is critical.

Drawing on the Group's extensive experience, the new HySafe Vertex vent panel has been through a comprehensive design and testing programme. It has been rigorously tested to ensure reliable and swift activation while preventing debris and missile hazards.

The design process began with outline analytical methods and simplified preliminary testing, followed by detailed explicit dynamics finite element analysis (FEA), and culminated in full-scale hydrogen deflagration testing at a specialised facility, which validated the vent panel's performance across a range of overpressure and impulse conditions.

The results from these design activities and full-scale tests have provided designers and specifiers with a clear and convenient pressure-impulse nomograph, showing the full loading envelope for panel activation. This performance data is also suitable for advanced computational fluid dynamics (CFD) explosion consequence modelling or coupled-fluid structure interaction models.

The robust validation of the HySafe Vertex vent panel, with a Pstat overpressure of 20 mbarg, is particularly valuable when using established deflagration venting standards like NFPA 68.



**Strength to  
Protect**



**Empirically  
Tested**



**Innovative  
Design**



Given that the panel design and testing programme was based on the challenging hazard of hydrogen deflagrations, the system is also well-suited to other deflagration hazards, including other flammable gases, combustible dusts, and the off-gases associated with lithium-ion battery thermal runaway.

Our comprehensive design and testing programme, which lasted three years, confirmed the satisfactory performance of the HySafe Vertex vent panel's perimeter framing, central spine, and associated fixings to the primary structure. It was estimated that outflow velocities through the opened vents approached 1,000 m/s during the most severe explosion tests.

The development of the HySafe Vertex vent panel highlights our team's commitment to innovation and safety. By employing a rigorous design process that includes outline analytical methods, preliminary testing, and extensive explicit dynamics FEA, the team ensured that the vents could perform reliably under the demanding conditions of hydrogen deflagrations.

The performance and reliability of the HySafe Vertex vent panel has significantly contributed to safer hydrogen storage, transportation and utilisation. These vents play a crucial role in advancing the hydrogen economy by mitigating the risks associated with hydrogen deflagrations and preventing the transition to detonation. The team's success has reinforced our position as a leader in safety solutions and set new industry standards for explosion relief technology.



The Rhino Engineering Group's success in the hydrogen industry is a testament to the expertise and dedication of our team. Combining deep industry knowledge with cutting-edge engineering practices, the team has successfully designed and fabricated low-inertia, rapid-acting explosion relief vents that address the unique challenges of the hydrogen economy.

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