ARIANE 5 IN THE WIND TUNNEL

Wind tunnel tests on a model of the Ariane 5 rocket helped provide assurances that the design of the Vulcan 2 engine is safe. NLR built the highly advanced model and conducted the wind tunnel tests.

The Vulcan 2 engine was developed in the late 1990s to give the Ariane 5 rocket extra thrust, allowing it to carry a bigger payload into space. Wind tunnel tests previously conducted by NLR with a scale model of the original rocket, revealed that the force exerted on the engine's conical exhaust nozzle was too great. Rocket manufacturer EADS Space subsequently went in search of a solution, conducting a series of advanced tests in the high-speed tunnel (HST) of German-Dutch Wind Tunnels (DNW). The designers tried to alter air flow around the rocket in various ways. For instance, by streamlining the steel supports between the fuselage and the side rockets, by placing serrations on the booster rockets, and by adding fins to the boosters. However, the results of these adjustments were insufficient. The solution was eventually found in 2004, by shortening the exhaust nozzle.

NLR manufactured the scale model and carried out the tests in cooperation with the DNW-HST. Owing to NLR's broad base of expertise, EADS was able to commission a single institute to develop the model and carry out the tests. The 86-centimeter-long scale model (1:60) of the Ariane 5 was made to a tolerance of less than 0.8 micrometer. To measure the forces generated by shock waves and turbulence, the 9-centimeter nozzle was equipped with 128 minuscule pressure sensors, each fed by hair-thin electrical wires and a thin tube to provide counter pressure. All of these connections led, over a distance of 5 meters, from the exhaust nozzle through the wind tunnel to connection points outside, via the mooring that holds the model in the wind tunnel. The pressures measured during the tests were recalculated as forces, so that EADS experts and NLR were able to make immediate adjustments.

The Ariane 5 turns on its axis during ascent and changes course. As a result, the airflow around the rocket changes continually. A wide range of airflow orientations were therefore tested in the wind tunnel. The forces exerted on the shortened exhaust nozzle of the Vulcan 2 engine always remained within acceptable limits. In November 2004, measurements taken during the first launch of an Ariane 5, which still had the longer exhaust nozzle, closely coincided with measurements obtained during NLR's earlier wind tunnel tests. This convinced the client to commission NLR and DNW to also conduct the tests on the shortened Vulcan 2 exhaust nozzles. Since then, the first Ariane 5 ECA rocket (Évolution Cryotechnique version A) with a shortened Vulcan 2 engine has been launched successfully.