A WATER-COOLING SYSTEM FOR THE JET-GUIDE AND DEFLECTOR OF THE ARIANE 6 LAUNCH BASE

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A jet-guide system has been produced with the scope of directing the jet of the new ARIANE 6 launcher towards the deflector, with the final aim of disrupting high sound frequencies that can damage the launch pad. This system must necessarily be equipped with a water-cooling system, to reduce the thermal stresses on the structure and protect the jet deflector. Moreover, this system will also be used to safely proceed with the on-site validation test of the Vulcain engine.

To correctly design the water-cooling system, it was shown necessary to include the geometric and performance simulation of the Vulcain engine, to predict the characteristics of the jet. Considering the overall duration of the test, equal to 500 s, and the heat flux of the engine jet, with peaks up to 400 kW/m^2, the water flow rates necessary to maintain the temperature were calculated. Finally, the distribution of the water itself inside the guide jet has been analyzed, so that the thermal stresses were contained within acceptable limits. Regarding this test, the same design process was used to optimize the shape of the deflector antennas, so that the excessive duration of the test (compared to any nominal launch) does not impact the integrity of the deflector itself.

This has led to a solution consisting of four tori, with a diameter of about 4m, two of which are internal and two external to the guide jet. They can supply 850 kg / s of water to the system. For the deflector it has been used 6 antennas that can supply over 1000 kg / s of water. The analysis of the distribution of flows was carried out at several levels, with particular attention to transient phenomena (such as water hammer) and stationary ones, to determine for each simulated case, the fields of velocity, temperature and water drop concentration. Particular attention was paid to the distribution of the jet to optimize and harmonize its "cooling" effect within the region of the protection plates of the turbopumps.

The result is therefore a system that is mechanically interfaced with the jet-guide to which it is directly welded. The two internal tori present a total of 220 holes, while 348 antennas have been installed on the external ones: they cross the converging-diverging cones that make up the jet-guide within the reduced interspace of 20 mm. The system has been tested in different configurations, nominal and 500 s test, with and without the flow from the deflector. The measured flow rates were found to be in line with the hydraulic design phase, as well as the distribution of the water jets which has a coverage consistent with the provisions of the dynamic simulations. Finally, the on-site test of the engine will allow the validation of the CFD models and the overall thermal effect of the water-cooling system.