Stargate within EU Green Deal

Project Fact Sheet

# Water Injection

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement GA101037053

## 01 BASIC PROJECT INFORMATION

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| **Project name** | **Water Injection** |
| **Partners involved** | **Brussels Airport Company**<br>**DLR** |
| **Implementing airport / site** | **DLR test facilities** |
| **Period tested** | **2026** |
| **Project lead / contact** | **Brussels Airport Company** |

## 02 OBJECTIVE

### What are we trying to solve or tackle with this project?

Assess whether injecting water into the hot exhaust plume downstream of an aircraft engine can reduce the environmental impact of engine run-ups, especially ultrafine particles (UFP). Noise reduction was an initial aim, but acoustic testing was excluded from the final proof-of-technology campaign. The work investigates air-quality benefits, technical feasibility and water needs before airport use.

### Success criteria

Assess whether water injection shows sufficient scientific potential for further research, by comparing particle, NOx and CO emissions with a no-water reference, assessing whether droplets reach the hot exhaust core and estimating aircraft-scale water demand.

## 03 APPROACH (HOW WE TESTED)

### Test set-up & method

Brussels Airport Company (BAC) and DLR replaced the initially planned commercial-aircraft demonstration with a more controlled test-bench approach using a Rolls-Royce M250 turboshaft engine. A single nozzle injected water at 2–6 L/min downstream of the exhaust, with emissions measured before and after injection. In parallel, CFD modelling of an A320-type engine with 16 circumferential nozzles explored how effectively water could penetrate the hot exhaust core and what water demand could be expected when scaling the concept to aircraft level.

### Data & measurement

**Experimental measurements:** Water was injected into the exhaust at different flow rates (2–6 L/min) and emissions were measured before and after the water injection point. Tests with water were compared with tests without water to understand its effect on particle emissions and gaseous emissions (NOx, CO and unburned hydrocarbons). Measurements also assessed how much of the injected water actually evaporated.

**Computer modelling:** In parallel, a computer simulation of the airflow and water droplets around an A320-type engine was used to explore how the concept could work at aircraft scale. The modelling assessed whether externally injected water could reach the hotter central exhaust, as well as how much water this would require. It assessed the feasibility of getting water to the right place, not the resulting emission reductions.
Noise was not measured/modelled during this study.

### Risks & mitigations

For a potential future roll-out at aircraft scale, key risks include the high water demand indicated by the CFD modelling and the possibility that part of the injected water does not fully evaporate. Remaining liquid water could create operational challenges and would need to be carefully managed. Further development should therefore focus on optimising injection location, nozzle configuration, droplet size and water flow to maximise evaporation and minimise overall water demand.

### Limitations

- Testing used a Rolls-Royce M250 test rig rather than a commercial aircraft engine, so results cannot be transferred directly to aircraft scale.
- The single-nozzle test setup resulted in incomplete evaporation and wall impingement, limiting the representativeness of the measured effects.
- Part of the injected water remained liquid and likely deposited on the duct walls, limiting the representativeness.
- Modelling assessed water penetration and distribution only, not particle capture or emission-reduction efficiency.
- Noise was not measured, so no conclusions can be drawn on potential noise effects.

# 04 RESULTS & IMPACT

## Key results

Experiments: Controlled M250 bench tests showed an **11% reduction in particle concentrations** versus no-water tests and a measurable yet limited NOx and UHC decrease, while CO remained unchanged. Water did not fully evaporate, approaching supersaturation above 4 L/min. Noise was not measured.

Modelling: A320-type CFD modelling indicated that **at least 3,500 L/min of water** would be required to reach the hot exhaust core. This assessed water penetration and demand, not emission reductions.

Overall: The results show **limited potential, but major scale-up challenges**, particularly around water demand and injection optimisation. No commercial-aircraft demonstration was performed.

# 05 RATINGS (QUICK ASSESSMENT)

### Deployment Approach

How standardised is the solution: can it be deployed off the shelf, or does it require extensive customization?

Off The Shelf — Custom-Built

### Investment Magnitude

From low-cost deployment to major investment.

Low Investment (less than €10k) — High Investment (more than €15mio)

OPEX ☐ ☐ CAPEX

### Sector Readiness

From non-existing or emerging standards, regulations, and certification pathways to fully established industry practices.

Emerging Framework — Established Framework

### Innovation Maturity

How does the solution score in terms of maturity, from low TRL experimental/pilot-stage to high TRL market-ready.

Experimental — Market-Ready

### Operational Impact

Does the innovation deliver targeted improvements or rather drastically transform processes and/or operations.

Incremental Improvement — Transformational Change

# 06 NEXT STEPS / RECOMMENDATION

### Recommendation

Continue targeted research before moving to aircraft-scale demonstration. Further work should confirm reproducible emission benefits and demonstrate that water demand and evaporation can be made operationally feasible.

### Next steps

- Optimise water injection experiment to improve evaporation and reduce water use.
- Test improved nozzle layouts for better water distribution and less wall impingement.
- Further analyse emissions, including UHC, aerosol composition and condensate quality.
- Improve the computer modelling using more engine types and nozzle configurations.
- Assess practical feasibility, including water supply, infrastructure, safety, costs and overall environmental impact.