UK Civil Aviation Authority

Regulatory Sandbox for Hydrogen as an Aviation Fuel – Round 3

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Chapter 1
Introduction

The Civil Aviation Authority is inviting industry, academia, and other organisations to join its Regulatory Sandbox to test hydrogen technologies that support the use of hydrogen as an aviation fuel. The tests will identify hazards, risks, safety challenges and gaps in current CAA regulations and evaluate the proposed mitigations through verification and validation.

Our intention is that the hydrogen sandbox will enable stakeholders to test hydrogen technologies and show how the proposed mitigations will either comply with or close gaps in current CAA regulations. This outcome of testing will enable the proposal of recommendations to create new hydrogen policies.

The call is open to individual organisations or consortia working on developing and using hydrogen as an aviation fuel. Participation in the Sandbox does not constitute regulatory approval, acceptance, certification, or authorisation.

Context

To reach Net Zero flying by 2050, the aviation industry has been investing in developing hydrogen propulsion solutions that offer the potential for zero-carbon emission flights. However, hydrogen as an aviation fuel is at an early stage of development.

As a result, industry and the CAA do not yet have a comprehensive understanding of the risks to aviation safety; industry has developed a limited number of hydrogen-related standards; and the CAAin collaboration with other National Aviation Authorities is) working on identifying the best way to certify hydrogen aircraft and license aerodrome hydrogen operations.

For industry, uncertainties about regulations are a potential barrier to:

- Developing hydrogen as an aviation fuel.
- Attracting further funds for R&D.
- Setting up a business model.

The hydrogen sandbox proposes the testing of hydrogen technologies to collect data to support the validation of proposed mitigations. This will enable the creation of required policies to facilitate the introduction of hydrogen in the aviation environment.

Chapter 2
Objectives

Our intention is that the Hydrogen Sandbox will be used by stakeholders to test their hydrogen technologies to propose policy recommendations.

The objectives of the sandbox are:

- The testing and evaluation of the CAA's Draft Hydrogen Refuelling Guidance Document.
- To demonstrate and validate specific hydrogen technologies to manage the safe integration of hydrogen as an aviation fuel.
- To assess the development of hydrogen superconducting propulsion and the use of AI in relation to hydrogen technologies in aviation.
- To provide structured, evidence-based feedback to support regulatory development and the emergence of best practice.

The Hydrogen Sandbox will be delivered using the Regulatory Sandbox methodology.[1] The Regulatory Sandbox methodology allows the CAA to develop policies that better meet the needs of the industry, and to shorten the lifecycle for developing these policies.

This is achieved by following cycles of hypothesis-driven experimentation in a controlled and safe environment to accelerate learnings, eliminate unknowns and uncertainties, and rapidly converge towards the design of a policy. These cycles are called Build-Test-Learn cycles, Figure 1.

The Hydrogen Sandbox is managed by the CAA Technical Strategy Lead Zero Emissions Flight as part of the wider Hydrogen Challenge project in collaboration with different teams and departments of the CAA.

[1] For more information on the methodology see the CAA's Regulatory Sandbox Guidance: FFC - Innovation Sandbox Guidance

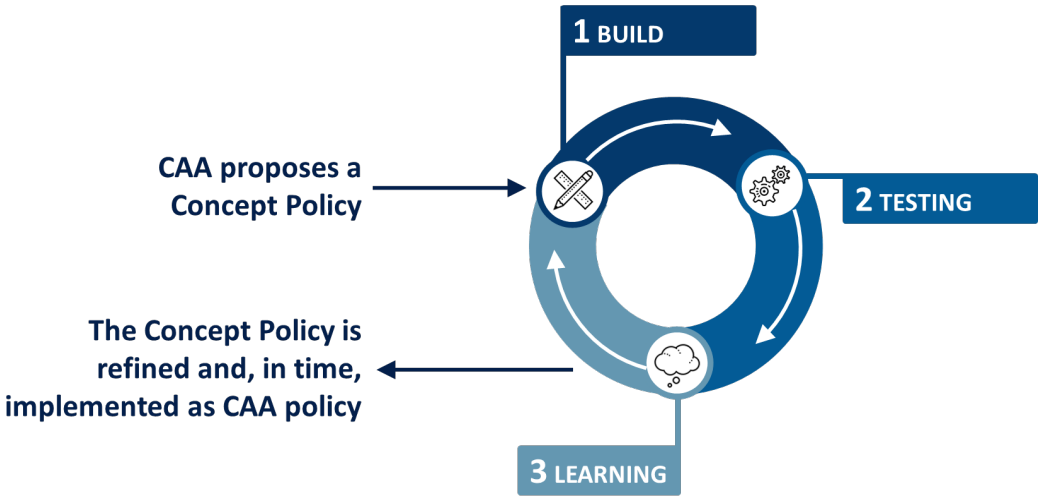

Figure 1 Functional aspects of the Sandbox

We offer Sandbox services prior to an application for regulatory approval being started. The Sandbox service is an advisory service offered prior to an application for regulatory approval being started. Sandbox services stop as soon as a regulatory application process starts. The CAA individuals involved in the Sandbox services cannot process the regulatory approval. The separation between Sandbox services and regulatory approvals mitigates risks with conflicts of interest can be seen in Figure 2.

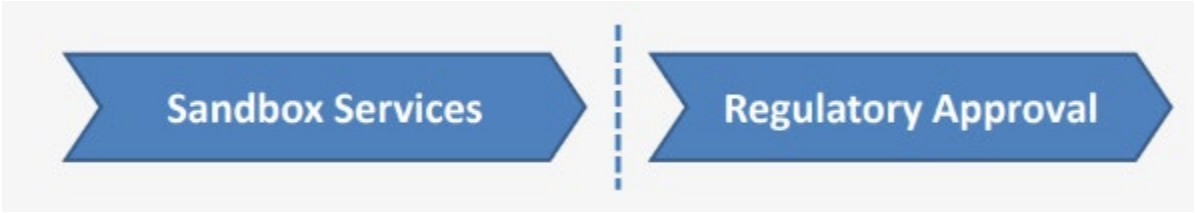

Figure 2 Regulatory separation from Sandbox services

Sandbox Services do not predispose regulatory decision making: Sandbox services do not, in any way, predispose regulatory decision-making. Regulatory decision making is made by the CAA's core regulatory teams that sit in another part of the CAA. Such outcomes remain the sole discretion of the relevant regulatory teams with reference to our statutory duties.

Chapter 3
Scope

We are looking for organisations planning to conduct flight or ground testing of technologies for the use of hydrogen as an aviation fuel. For this sandbox round we have four **priorities**.

First, this Sandbox focuses on the **introduction of hydrogen within the aerodrome environment**, with particular emphasis on:

- Aircraft refuelling operations.
- Associated ground handling and apron activities.
- Emergency preparedness and RFFS response.
- Supporting infrastructure and systems.

This is linked to the assessment through this Sandbox of the CAA's Draft hydrogen refuelling document. As such applicants applying for projects within the aerodrome environment will be expected to evaluate relevant elements of the draft guidance in the context of their proposed operations and to assess its suitability, robustness and usability in realistic aerodrome operational environments. (Please see Annex I that provides three potential use cases and more detailed information on proposed projects focusing on hydrogen refuelling).

Second, in this third round of sandbox within the Hydrogen Challenge, we are looking for projects focusing on the one hand on the potential use of **Artificial Intelligence** for the introduction of hydrogen technologies in aviation. Such projects could focus on the following subjects:

- How AI can accelerate the development of hydrogen-ready aircraft, systems and infrastructure.
- Using AI to accelerate advances in hydrogen compatible materials and fuel system technologies.
- Intelligent systems to detect, predict, and mitigate risks unique to hydrogen aviation.
- Tools that help industry generate evidence and help regulators evaluate new hydrogen technologies.
- AI-enabled autonomous or semi-autonomous systems that handle H2 safely and efficiently.

Third, we are also keen to receive proposals focusing on **superconducting motors and hydrogen**. Such projects could include the following topics:

- Ground or flight testing of a superconducting motor prototype
- Safety and reliability requirements of the superconducting network
- Superconducting motors cooled by gaseous or liquid hydrogen
- Heat management systems

Fourth, we are keen to receive proposals focusing on **hydrogen aircraft technologies**. Such projects could include:

- Hydrogen fuel cells and combustion
- Sensors and leak detection
- Aircraft zonal analysis
- Storage of hydrogen on the aircraft (tanks)
- Hydrogen phase change (LH2 to GH2)
- Hydrogen fuel systems

If you project does not fit in any of the above areas, we will also consider project including the following hydrogen operating areas:

Technology Areas			
Hydrogen gas turbines	Fuel cells	Hydrogen tanks	Hydrogen distribution
Thermal management	Aircraft design	Aircraft systems	Airports
Ground operations	Superconducting technologies	Refuelling	AI and Hydrogen

This call is open to individual organisations or consortia working on the development of hydrogen technologies for use in aviation. Sandbox applicants must be working on a test programme that works towards testing their hydrogen technologies (ground test or flight test) by being able to demonstrate the following conditions:

- The applicant must be able to explain how their participation in the sandbox will support the introduction of hydrogen as an aviation fuel.
- The application must be able to demonstrate the TRL of their technology where applicable.
- The applicant must be ready to start testing in the sandbox and support the full duration of the test plan developed.

- A test plan must be available and clearly outline that testing can be completed by March 2028, including the key milestones and outputs of these activities.
- The applicants must be competent and experienced in developing new technologies in the above technology areas.
- Building on previous projects developing hydrogen technology (Please list the projects).

NB: Any regulatory approvals will be separate from the Hydrogen Sandbox [e.g., permit to Fly (PtF)]

Chapter 4

Sandbox Application

What you will get from us

The organisation(s) which enter the CAA Regulatory Sandbox will receive support from a dedicated hydrogen challenge team member and regulatory subject matter experts, who will:

- Collaborate on identifying hazards, risks, and safety challenges associated with the use of hydrogen.
- Provide feedback on the safety argument for hydrogen operations in the aviation environment.
- Review gaps in current CAA regulations that apply to hydrogen as an aviation fuel.
- Review of the trial plan for testing in the hydrogen sandbox to ensure both the CAA and participant objectives are realized.
- Provide a critical review of the test data obtained through operations in the hydrogen sandbox and associated final reports.
- Ensure lessons learnt through testing are captured to support the development of the policy.

NOTE: The CAA does not offer any funding to the participants of the Regulatory Sandbox.

However, all CAA support and access to subject matter experts for the sandbox activity will be free of charge to the selected participant(s).

What we expect from you

Successful applicants will undertake a structured programme of activities, which may include:

- Biweekly meetings on progress and new issues or developments relating to the project
- Workshops and stakeholder engagement
- Practical demonstrations and exercises
- Hazard identification and safety analysis

- Development and evaluation of safety cases

Participants will be required to provide the CAA Hydrogen Challenge team with information related to their hydrogen technologies and their project activities, including:

- Test results
- Gaps and limitations
- Areas for improvement
- Matters requiring clarification

Sandbox outputs will be used to refine guidance material and, where appropriate, inform future regulatory policy and industry best practice.

At the end of each sandbox project, the results of the project and a summary of the activities carried out will become publicly available.

How to apply

To apply, you will need to send us the following documents:

- A completed application form (available by hydrogenchallenge@caa.co.uk), ensuring you provide the administrative information requested.
- A project proposal/ConOPS including the following information as a minimum:
    - Project's objectives and their relevance to the Regulatory Sandbox for Hydrogen.
    - Overall structure of work and a clear test plan.
    - Timing of work packages and testing activities (Gantt chart).
    - The key hydrogen technologies, systems, concepts and/or innovations that will be used in the project and their TRL.
    - A list of key milestones and deliverables.
    - A table with the risks relating to project implementation.
    - Purpose of the test you need to run in this particular sandbox.
    - How can the CAA support you with your project.
    - A description of laws, rules, standards and/or policies you have already considered.

If any of the requested information is not included in your proposal, then your application will not be accepted for evaluation.

NOTE: Successful applicants/consortia will be required to enter into a memorandum of understanding (MoU) and non-disclosure agreement (NDA) with the CAA. Please review the provisions of these documents as there will be no scope to negotiate them.

If you have any questions about the application process, please contact us through our email address: hydrogenchallenge@caa.co.uk

Timelines

An overview of the timelines:

- The application period for this sandbox will close on **30/06/2026 at 12:00 hrs GMT**. Applications received after this time will not be accepted.
- Applications will be reviewed and assessed for inclusion in the sandbox and all bidders will be notified within of the outcome.
- Successful bidders will be onboarded to the sandbox.
- A virtual kick-off meeting will be arranged within of notification of onboarding to the sandbox to explain the next steps to all parties.
- Individual one-to-one meetings will be held to provide feedback on the proposed ConOps and establish a project timeline.

The sandbox will only be opened once, and once the application phase has closed, no other applications for this sandbox will be accepted.

APPENDIX A

Use Cases – Hydrogen refuelling

1. Ground- Based Demonstration of Hydrogen Refuelling for Aviation

Purpose

This call includes participation in a live, ground-based demonstration intended to test and inform draft guidance for hydrogen aircraft refuelling. The demonstration will use a representative hydrogen fuel tank and refuelling system, without an aircraft present.

The objective is to gather operational evidence and lessons learned to support the development of safe, practical, and proportionate refuelling guidance.

Scope

The demonstration will include:

- A representative aviation hydrogen fuel tank (compressed gaseous or liquid)
- A representative hydrogen refueller or ground support system
- Execution of an end-to-end refuelling operation, including:
    - Connection and disconnection
    - Purging and inerting
    - Fuel transfer operations
    - Monitoring and control
    - Emergency stop procedures

Out of Scope

- Aircraft installation or integration
- Flight operations
- Certification or approval of specific products

Objectives

The demonstration will assess:

- Practicality, clarity, and completeness of the draft refuelling guidance

- Applicability of proposed safety controls, procedures, and defined roles
- Human factors considerations during live operations
- Emergency response assumptions and operability

Demonstration Requirements and Safety Expectations

Participants should provide:

- A hydrogen tank representative of aviation use (materials, pressure and temperature range)
- A refuelling system representative of airport operations
- Instrumentation sufficient to monitor pressure, temperature, and flow
- Documented operating and emergency procedures

Demonstrations must be conducted under an appropriate safety management framework.

Participants will be expected to submit:

- A hazard identification and risk assessment
- Emergency response arrangements
- Evidence of personnel competence and training
- Confirmation of compliance with applicable hydrogen safety standards

Data Collections and Outputs

Participants will support the collection of:

- Observations against the draft guidance
- Operational timings and deviations
- Operator feedback and lessons learned

Findings will be used in an aggregated, non-attributable form, unless otherwise agreed.

Participation and Expression of Interest

Interested organisations are invited to submit an expression of interest outlining:

- Proposed tank and refuelling configuration
- Hydrogen type and operating parameters
- Proposed location and timeframe
- Summary of safety arrangements

2. Hydrogen Fuelled Ground Support Equipment (GSE)

Purpose

The CAA invites Sandbox applications proposing structured, evidence-led research and trials into the introduction and operation of hydrogen-fuelled ground support equipment (GSE) within conventional aircraft turnaround environments.

Proposals should focus on operationally representative scenarios and generate learning that supports the safe and proportionate integration of hydrogen-fuelled GSE alongside existing diesel, electric, and hybrid fleets.

Areas of Interest

Areas of particular interest include, but are not limited to:

- Integration with existing airport infrastructure and procedures
- Mixed-fleet operations (diesel, electric, hybrid, and hydrogen)
- Turnaround timelines and operational impacts
- Spatial planning, zoning, segregation, and access control requirements
- Hydrogen-specific hazard identification, risk assessment, and mitigation
- Emergency response considerations, including interaction with RFFS and aerodrome emergency plans
- Human factors, training requirements, and behavioural adaptation across operational and emergency roles.

Demonstration Requirements

Sandbox proposals should clearly articulate how the trial or demonstration will:

- Be operationally realistic, reflecting routine aircraft turnaround activities rather than limited or laboratory-style demonstrations
- Define the scope, scale, and duration of hydrogen GSE use, including limits on quantities, operating envelopes, and environmental conditions
- Identify success criteria and measurable outputs, including safety performance indicators and operational learning objectives
- Provide an evidence-led approach to assumption testing, highlighting known uncertainties and evidence gaps
- Include arrangements for data capture, incident reporting, and learning dissemination to support wider regulatory and industry benefit.

Safety Expectations

Applicants are expected to demonstrate that risks associated with hydrogen-fuelled GSE are systematically identified, assessed, and managed, and that safety is maintained at least to an equivalent level as existing GSE operations. Proposals should include:

- A clear safety argument, supported by hazard identification, risk assessment, and defined mitigations
- Consideration of normal, abnormal, and emergency operating conditions
- Alignment with existing aerodrome safety management systems and procedures, including change management processes
- Defined interfaces with emergency services, including RFFS familiarisation, competence, and information provision
- Proportionate training and competency requirements for operators, supervisors, maintainers, and emergency responders
- Human factors considerations, including workload, task allocation, situational awareness, and behavioural responses to hydrogen-specific risks.

Regulatory Collaboration

The Sandbox is intended to support collaborative learning, enabling participants to work in partnership with the regulator to:

- Test regulatory and operational assumptions
- Identify evidence gaps and areas requiring further development
- Develop and validate proportionate safety mitigations
- Inform future guidance, policy, and certification approaches

3. Aerodromes Emergency Expertise – Hydrogen Aircraft

Purpose

Applications are also welcomed from aerodrome operators and aircraft operators proposing to test, validate, and refine aerodrome emergency planning arrangements involving hydrogen-powered aircraft.

Exercises should be designed to be credible, operationally representative, and evidence-generating, supporting both local assurance and wider regulatory learning.

Exericse Format

Exercises may be conducted as:

- Table-top simulations, or
- Practical, full-scale emergency exercises

A blended or progressive approach (e.g. table-top followed by live exercise) is also encouraged where appropriate.

Indicative Scenarios

Indicative scenarios may include, but are not limited to:

- Hydrogen refuelling or defuelling incidents
- Ground handling events involving hydrogen fuel systems
- Aircraft accidents or serious incidents where hydrogen is the primary energy carrier
- Escalating fault or emergency scenarios requiring multi-agency response

Demonstration Requirements

Proposals should clearly define how the exercise will:

- Test realistic emergency conditions, including time pressure, uncertainty, and concurrent operational demands
- Define the scope, scale, and level of representativeness of the exercise, including aircraft configuration, fuel state, and environmental conditions
- Involve relevant stakeholders, including RFFS, aerodrome operations, aircraft operators, ground handlers, and emergency partners as appropriate
- Set out objectives, success criteria, and evaluation methods, including how performance and decision-making will be assessed
- Capture structured evidence, including observations, data, and participant feedback, to support learning and regulatory insight.

Safety Expectations

Applicants are expected to demonstrate that exercises are planned and delivered safely, while still enabling meaningful stress-testing of emergency arrangements. Proposals should include:

- A clear exercise safety plan, identifying hazards associated with hydrogen, live response activity, and participant interaction
- Proportionate risk controls to protect participants, responders, and infrastructure during exercises

- Consideration of normal, abnormal, and worst-credible hydrogen hazard conditions, including fire, release, and gas dispersion
- Alignment with existing aerodrome emergency plans, RFFS procedures, and safety management systems
- Defined arrangements for RFFS competence, familiarisation, and equipment suitability for hydrogen scenarios
- Human factors considerations, including command and control, situational awareness, communications, and decision-making under stress

Expected Outputs

Expected outputs from exercises include:

- Identification of gaps, assumptions, or limitations within existing emergency planning arrangements
- Assessment of RFFS readiness, tactics, training, and equipment in hydrogen-related scenarios
- Evaluation of interoperability between hydrogen aircraft response arrangements and conventional aircraft emergency response
- Documented lessons learned, recommendations, and proposed mitigations, suitable for informing internal improvements and wider regulatory learning.