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# ARM Aerial Facility Challenger 850 Research Jet

In 2019, the U.S. Department of Energy's (DOE's) Atmospheric Radiation Measurement (ARM) user facility purchased a research jet for the ARM Aerial Facility (AAF).

The jet replaces ARM's vintage Grumman Gulfstream-159 (G-1) turboprop aircraft that, for three decades, helped advance atmospheric research in field campaigns across the world.

Following a careful needs evaluation, ARM acquired a Bombardier Challenger 850 regional jet. The Challenger 850 has low time on its engines and airframe, having logged less than 2,600 takeoffs and landings and fewer than 5,500 airframe/engine hours. The jet was built and used as a business jet, stored in a hangar, and repainted in 2015.

Manufactured by Bombardier until 2012, the Challenger 850 was the largest "super-midsize" business jet offered by Bombardier. A typical configuration for the airline version of this airframe (Bombardier CRJ 200) holds about 50 passenger seats.

With ARM's previous aircraft, the G-1, space was limited, and there was often little or no room for campaign investigators. The additional space of the Challenger 850 allows more instruments and—depending on the instrument configuration—room for up to seven scientists.

Not only does the new jet have the previous aircraft's capability of flying low and slow for some experiments, but it also can venture into higher elevations and more safely fly through and collect data in stormy weather conditions. The Challenger 850 can reach a top elevation of around 40,000 feet for scientific study, depending on ambient temperature and weight, primarily determined by instrument payload and fuel volume, almost doubling what the G-1 could reach.

The new jet improves upon ARM's data collection capabilities, with additional types of aerial sampling, the power to climb and descend more quickly within desired areas of interest, and the ability to fly much higher. For example, researchers will now be able to sample high cirrus clouds.

With a much larger geographic range, the new jet will also greatly expand the extent that AAF instruments can easily measure for the AAF's far-flung field campaigns.

## A New Laboratory in the Sky

Recognizing the need for a new plane, the AAF in 2016 began an effort to secure funding for a new aircraft. This effort included a multistep process to establish and review the aircraft requirements. In fiscal year 2019, Congress allocated funding of $17.5 million to purchase and retrofit a new research aircraft.

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## Selection Criteria

During the aircraft selection process, ARM's criteria included:

- a payload capacity to carry multisensor packages for concurrent measurements of aerosol, trace gas, clouds, and solar and infrared radiation
- a physical structure that allows the installation of in-cabin instruments, free-airstream sensors, and radiometers
- an ability to fly between the surface and 25,000 feet to gather data on a range of scientific priorities, including information on land-atmosphere interactions, boundary-layer structure, and mixed-phase cloud microphysics
- the ability to efficiently fly as low as 200 feet to gather in situ observations of aerosol and cloud microphysical properties
- the ability to operate in conditions ranging from the Arctic to the tropics with a full payload
- a flight duration of at least five hours with a full payload
- the capability of flying during atmospheric phenomena of interest
- the ability to conduct multi-week to multi-month campaign deployments worldwide consistent with commonly available aircraft support infrastructure.

## Aircraft Specifications

**Challenger 850 Specifications**

- Flight crew: 2
- Overall length: 87.83 feet
- Wingspan: 69.58 feet
- Cabin length: 43.25 feet
- Cabin width: 7.25 feet
- Cabin height: 6.08 feet
- Floor space: 250 square feet
- Engines: General Electric CF34-3B1 turbofans
- Range: 2,811 nautical miles
- Typical cruise speed: 509 mph
- Takeoff distance: 6,305 feet
- Landing distance: 2,910 feet
- Maximum altitude: 41,000 feet

## ARM's Long Flight to New Science Missions

The Challenger 850 will be modified from its current business jet configuration to accommodate ARM instrumentation, both within and outside the aircraft.

After the modification phase, the aircraft will enter a scientific readiness phase. The installed scientific systems will be tested, pylons will be adjusted to be in line with airflow, modernized data acquisition will be installed, and inlets mounted.

The Challenger will have three inlets that bring in ambient air—one each for droplets/ice crystals, aerosols, and trace gases.

Numerous test flights will be conducted with a full complement of instruments to verify readiness for the ARM scientific mission. Meanwhile, existing and yet-to-be-hired AAF pilots and maintenance staff will be trained on the new airframe.

This Challenger 850 is expected to be ready for its first ARM science campaign in 2023. ARM held a workshop on the new aircraft in early March 2020.

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