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Preparing for Air Quality Airborne Science

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NASA's DC-8 flying laboratory is based at Armstrong Flight Research Center Hangar 703 in Palmdale, California. Credit: NSERC/Jane Peterson

by Kate Squires/ PALMDALE, CALIFORNIA/

There are many layers to orchestrating a mission as complex as the Korean U.S. Air Quality (KORUS-AQ) study, which gets underway next week in South Korea. Preparing the aircraft and science instruments to come together as one is just a single layer, but it's an extremely important one for ensuring a safe and successful mission.

KORUS-AQ, a joint field campaign by NASA and South Korea's National Institute of Environmental Research, will combine observations from aircraft, satellites, ships and ground stations to assess air quality across urban, rural and coastal areas of South Korea. These data will help shape the development of the next-generation system of space- and ground-based sensors for air quality monitoring and forecasting.

Credit: NASA / Brian Soukup

NASA's DC-8 flying laboratory looks like a normal passenger jet, but it's far from it. The highly modified aircraft has removable seats, ports and windows. The onboard electronics have also been modified to support a variety of instruments. Despite the many "holes" in the aircraft, the structure is highly stable.

Instrument integration work began a month prior on March 21 when the instruments were shipped to the science lab at Armstrong Flight Research Center's Hangar 703 in Palmdale. Some of the instruments arrived in pieces and had to be built from the ground up before they were installed. Others arrived fully assembled and only needed to go through power and other system checks before they were ready for installation.

Before loading instruments into the plane, DC-8 quality inspector Scott Silver inspected each of the instruments for "air worthiness" in the science lab. He made sure that each instrument did not emit sparks or smoke or create other hazards that could potentially cause problems during flight.

"Once the instrument is on the plane, it's not coming off. But we need to make sure it's safe before we even get to that point," Silver said.

While the scientists made sure their instruments were functional, aircraft mechanics removed windows on the aircraft and installed a wide variety of air intake probes. They also installed optical ports into the top and bottom of the plane for laser sensors. After port installation was done, the aircraft looked somewhat like a porcupine.

Air intake probes protrude from NASA's DC-8 flying laboratory in place of normal window ports for the Korean U.S. Air Quality (KORUS-AQ) mission. Credit: NASA / Carla Thomas

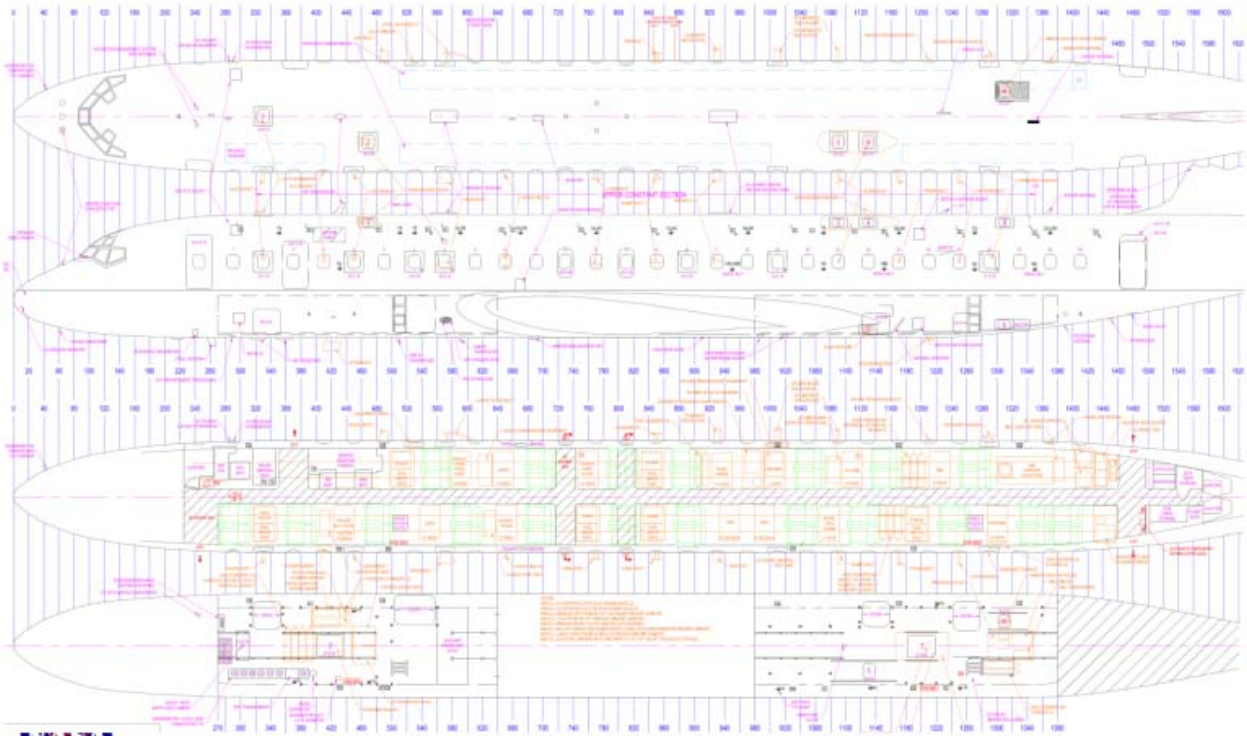
Each instrument was then rolled out of the science lab and placed on a large scale to be weighed for aircraft weight and balance requirements. From there, each instrument was loaded onto a lift and carried up to the aft doors of the aircraft.

This part was tricky. Cabin space is limited and the payload of 26 instruments is large compared to most DC-8 missions. So instruments had to be loaded in a specific order, starting with the instruments located at the front of the plane.

Alan Fried, University of Colorado Boulder, makes an adjustment to the intake for the Compact Atmospheric Multi-species Spectrometer (CAMS) instrument, which will measure formaldehyde and ethane in the atmosphere over South Korea. Credit: NASA / Anna Kelley

Mechanics, avionic techs, data system engineers, and experimenters worked side-by-side to install each instrument without causing delays to the 10–20 instruments in the queue behind them. The experimenters were then free to make sure their instruments were working and communicating with the onboard data system.

After installation, the aircraft was moved outside of the hangar to allow the experimenters to calibrate the instruments. The aircraft was then turned back over to the DC-8 crew who performed necessary aircraft maintenance checks on the engines and cabin pressure.



The blueprint plans for integrating the 26 science instruments look daunting, but NASA's DC-8 crew has a method to the madness. Credit: NASA

"Our primary job at NASA Armstrong is to make sure that all of the experimenters onboard are safe and can focus on collecting as much data as possible," DC-8 crew chief Corry Rung said.

The final checks happened throughout several short flights. The first on April 15, called a "shake flight," ensured that none of the instrument hardware was loose and that they all functioned correctly. The second two flights on April 18 and 22 were devoted to testing the science instruments themselves. The DC-8 is slated to leave California for Osan Air Base on April 26.

Inside the cockpit of the DC-8 during the April 21 science check flight. Left seat pilot, Dick Ewers; right seat pilot, Dave Fedors; and flight engineer Matt Pinsch. Credit: NASA / Carla Thomas

Meanwhile across the country at NASA's Langley Research Center in Hampton, Virginia, the UC-12B King Air was going through a similar integration process. However, because the King Air has a smaller fuel tank and payload capacity, the aircraft cannot make the transit flight across the Pacific with all of the instruments on board.

After the science instruments were installed, fitted and checked, they were quickly uninstalled and packed into shipping boxes headed to Osan Air Base. The aircraft was then outfitted with large fuel bladders that will help the aircraft to make the long transit flight. The fuel bladders will be stored inside the aircraft fuselage. Once the King Air aircraft arrives, the crew will reintegrate the science instruments just before the field campaign begins.

Johnathan Hair, NASA Langley Research Center, tests the DIAL UV instrument during a science check flight. DIAL UV measures ozone and also simultaneously measures aerosols and clouds. Credit: NASA / Carla Thomas

The King Air departed Langley Research Center on April 18 and will make stops at Ames Research Center in California, Anchorage, Alaska, Adak Island (Aleutian Islands) and Kadena Air Base in Japan. The aircraft is scheduled to arrive at its destination at Osan Air Base on April 25.

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