The Integrated Systems Research Program (ISRP), a new program effort that began in FY10, will conduct research at an integrated system-level on promising concepts and technologies and explore, assess or demonstrate their benefits in a relevant environment. The integrated system-level research in this program will be coordinated with on-going long-term, foundational research within the three other research programs, as well as efforts within other Federal Government agencies. As the NextGen evolves to meet the projected growth in demand for air transportation, researchers must address the national challenges of mobility, capacity, safety, and energy and the environment in order to meet the expected growth in air traffic. In particular, the environmental impacts of noise and emissions are a growing concern and could limit the ability of the system to accommodate growth. ISRP will explore and assess new vehicle concepts and enabling technologies through system-level experimentation to simultaneously reduce fuel burn, noise and emissions, and will focus specifically on maturing and integrating technologies in major vehicle systems/subsystems for accelerated transition to practical application.

ISRP is comprised of one project - the Environmentally Responsible Aviation (ERA) Project.

Environmentally Responsible Aviation (ERA)

The project's primary goal is to select vehicle concepts and technologies that can simultaneously reduce fuel burn, noise and emissions; it contains three subprojects: Airframe Technology, Propulsion Technology and Vehicle Systems Integration.

- Testing unconventional aircraft configurations that have higher lift to drag ratio, reduced drag and reduced noise around airports;
- Achieving drag reduction through lamimlar flow;
- Developing composite (nonmetallic) structural concepts to reduce weight and improve fuel burn; and
- Testing advanced, fuel-flexible combustor technologies that can reduce engine NOx emissions.

Subtopics
**A5.01 Laminar Flow Ground Testing**

*Lead Center: LaRC*

Laminar flow enabling technologies are required to allow the Environmentally Responsible Aviation (ERA) Project to simultaneously achieve its aggressive fuel burn, noise, and emissions goals for the N+2 timeframe. To achieve these breakthrough achievements related to drag reduction, the system level requirements for viable aircraft configurations utilizing laminar flow technologies must be established. Although numerous flight tests have proven the aerodynamic possibilities, such flight tests are much too expensive to allow for extensive parametric exploration and optimization to reduce the risks. Therefore, one of the key contributions needed to further advance the technology readiness level of laminar flow technologies integrated into vehicle concepts is the ability to conduct ground-based testing at relevant chord and unit Reynolds numbers. To achieve this need, the ERA Project plans to use the National Transonic Facility (NTF). The NTF is a pressurized, cryogenic wind tunnel capable of approximately 45 million chord Reynolds numbers at transonic speeds.

To date, testing has been done on a Natural Laminar Wing Model with mixed results. The preliminary results indicate contaminants in the flow path of the wind tunnel contributed to early boundary layer transition on the model. These contaminants are suspected to be a combination of minute frost particles, oil droplets, and dust. Based on the surface quality requirements for laminar flow testing at the conditions of the NTF contaminants as small as a few microns are sufficient to disrupt the stability of the boundary layer.

This solicitation seeks proposals to develop:

- Wind tunnel circuit cleaning techniques/processes to remove oil and dust contaminates from the NTF and other similar facilities. Because of the cryogenic testing requirements for dry test circuits water-based approaches are discouraged. The proposed process needs to demonstrate that particles and oil at the micron level can be sufficiently captured and removed from the test environment.

- Methods to polish, clean, and protect the surface quality of a wind tunnel model leading edge to sufficient levels to enable successful laminar flow testing at the NTF.

**A5.02 Open Rotor Installed Thrust**

*Lead Center: AFRC*

NASA’s Environmentally Responsible Aviation (ERA) project seeks simultaneous, aggressive reductions in noise, emissions and fuel burn for transport category aircraft in the N+2 timeframe. A significant reduction in Specific Fuel Consumption (SFC) will be required to meet the goal of a 50% reduction in fuel burn.

One path that engine manufactures are proposing to meet the required SFC improvements is a return to the open rotor technology first tested in the 1980’s. Many challenges to using open rotors on future generations of aircraft exist, both from the design and operations standpoint. One of the design challenges of the open rotor is determining the in-flight installed thrust of the open rotor on the aircraft.

Current practice with turbofans involves an extensive series of ground tests that determine corrections for the installed engine thrust relative to its measured uninstalled configuration. Currently, there is no acceptable method
that has been proven to duplicate this for open rotors. Additionally, there is currently no way to directly measure thrust during flight on an installed engine for this class of aircraft.

This solicitation seeks proposals to develop and validate:

- Develop methods and techniques to correct ground tested thrust measurements for installed, in-flight effects of an open rotor propulsion system.
- Develop methods and conceptual designs for hardware that would allow for the direct measurement of thrust in flight, throughout the full flight envelope. This measurement system must be robust enough to withstand the full flight and maneuvering envelop used during flight testing of a new aircraft while being precise enough to measure the thrust at all power settings.

A5.03 Variable Cycle Propulsion

**Lead Center:** GRC

Proposals for the variable cycle propulsion subtopic will address engine and engine integration topics as outlined in this section in support of the Integrated System Research Program.

Variable cycle propulsion concepts can potentially help the Environmentally Responsible Aviation (ERA) Project reach its aggressive fuel burn, noise, and emissions goals for the N+2 timeframe by taking advantage of engine and engine/airframe integration concepts that allow the system to optimize over the entire flight envelope. For example, a variable cycle concept may allow the aircraft system to fly efficiently at multiple flight speeds or altitudes, shift noise and emissions production to less critical phases of the mission, or allow for more efficient operation within airspace constraints.

Proposals are solicited that address this opportunity by developing system analysis tools and applying them to variable cycle engine concepts that can address the mission fuel burn, noise, and emissions goals for the ERA Project. Proposed efforts should identify one or more specific variable cycle concepts and assess their impact upon all three ERA metrics (fuel burn, noise, and emissions) for at least one representative long range, subsonic transport, passenger or cargo mission profile (60,000 to 100,000 lbs equivalent payload carried for 6000 nmi, at approximately 0.78-0.85 Mach number). System analysis tools should be developed and employed to adequately capture the combined effects of engine architecture concepts and their integration into airframe designs envisioned for the N+2 timeframe. Specific enabling technologies for these variable cycle system concepts should be identified and prioritized for future development. Such enabling technologies may include, but are not limited to concepts related to engine inlet, fan, compressor, combustor, turbine, nozzle components and their integration.