VFR – IFR – and now DFR!

NASA/TM–20220013225

Digital Flight:
A New Cooperative Operating Mode to Complement VFR and IFR

David Wing and Andrew Lacher
Langley Research Center, Hampton, Virginia

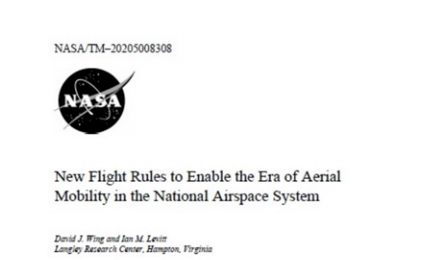
Wes Ryan
Ames Research Center, Moffett Field, California

William Cotton
Cotton Aviation Enterprises, Inc., Lakeway, Texas

Ruth Stilwell, D.P.A.
Aerospace Policy Solutions, LLC, Lauderdale-by-the-Sea, Florida

John Maris, PhD, and Paul Vigda
Advanced Aerospace Solutions, LLC, Fort Lauderdale, Florida

September 2022



NASA/TM–20205008308

New Flight Rules to Enable the Era of Aerial Mobility in the National Airspace System

David J. Wing and Ian M. Levitt
Langley Research Center, Hampton, Virginia

November 2022

By Dave Porter
dhporter@ifalda.org

In the 21st Century, new aviation markets, vehicle types, and technologies are fast emerging, inspiring new operational concepts for the National Airspace System such as Unmanned Aircraft Systems Traffic Management and Urban Air Mobility.

These novel operations envision a dramatic increase in aerial mobility, or the ability to navigate freely through the airspace with unprecedented access and operational flexibility. Implementing these concepts presents a major challenge to the existing operational modes of Visual Flight Rules (VFR) and Instrument Flight Rules (IFR), developed under the limitations of early 20th Century technology and procedures to ensure safe navigation and separation from traffic.

To meet this challenge and to support the needs of operators in the 21st Century and beyond, this paper proposes that VFR and IFR be augmented by new flight rules – Digital Flight Rules (DFR) – that leverage modern and emerging technologies and are not bound by restrictions borne of the state of technology 75-100 years ago.

The objective of DFR is to provide safe and unfettered access to the airspace to all participating vehicle operators under all visibility conditions without incurring the limitations in operational flexibility inherent to IFR and even VFR. Advancements in communications, navigation, surveillance, aircraft connectivity, information access, automation technology, and supporting ground infrastructure provide the opportunity for the vehicle operator to engage at an unprecedented level in managing their flights. regardless of flight visibility.

Under DFR, these advancements enable the vehicle operator to assume full responsibility for traffic separation and therefore full trajectory management authority in all visibility conditions and airspace regions. The changes in roles and responsibilities are expected to enable greater airspace access and

operational flexibility than afforded by IFR and VFR, thus enabling the emergence of new operations and a new era of advanced aerial mobility.

First…. what I'm describing here is "future-state". New and evolving technologies and procedures will influence future air traffic demand and capacity flow management. One of these is Digital Flight Rules (DFR), a proposed third operating mode to complement VFR and IFR. DFR is described in a NASA Document - NASA/TM–20220013225 - *A New Cooperative Operating Mode to Complement VFR and IFR*, published in September 2022.

Digital Flight Rules (DFR) is being developed to accommodate unpiloted air vehicles that need to operate partly in Class A airspace, currently controlled by ATC under IFR clearances, in order to ascend up into Upper Class E airspace. Many of these air vehicles will operate in the ETM (Upper Class E airspace above FL600) for extended periods of time... days or weeks…so-called HALE operations…High Altitude Long Endurance. Other UAM (Urban Air Mobility) air vehicles will operate in Lower Class E airspace, near the surface.

There are several types of air vehicles involved. First, we think of military drones, piloted from the ground by a qualified pilot manipulating the flight controls of the aircraft. These tend to be "full-size" aircraft capable of carrying meaningful payloads, including weapons, over long distances. There are also manned supersonic aircraft operating in Upper Class E airspace. DFR is not really required for these types of operation although it is planned to be included.

The air vehicles in mind that would require a DFR environment are smaller…up to several hundred pounds…solar-electric fixed-wing aircraft; balloons and airships. These would not be piloted by someone manipulating controls from the ground but rather would be programmed through an on-board flight management system (FMS) to take off, ascend at a prescribed rate over a planned flight path to a specific altitude, perform its mission then return to earth. Because these air vehicles lack the maneuverability and fast transient ability to respond to ATC separation instructions, a fairly wide area of real estate will be required to be NOTAM'd off, probably with a TFR, to isolate the operation from IFR traffic under ATC control while ascending and descending through Class A airspace.

The "future-state", however goes out to 15-25 years when DFR is meant to be an option for all flights operating in Class A airspace, including airline flights. They will in a CCE (Cooperative Community Environment) under Digital Flight Rules using autonomous separation technology. These operations will have to co-exist in Class A airspace with ATC-controlled IFR traffic as well as VFR flight tracking procedures.

DFR is a proposed new operating mode for <u>all airspace users</u>, complementing and adding to the existing operating modes of VFR and IFR and providing for cooperative integration in controlled airspace. Under new digital flight rules, requirements are set for its sustained use; and, qualified operators may employ DFR to enhance their airspace access and operational flexibility in all visibility conditions and eventually <u>all airspace classes</u> without requiring segregation from incumbent operations.

DFR is initially proposed for Unmanned Aircraft System Traffic Management. FAA describes this as being predicated on layers of digital information sharing to achieve safe operations. Operators will share flight intent with each other and coordinate to deconflict and safely separate trajectories, without reliance on visual procedures <u>or ATC separation services</u>.

Initially…within the next 3-5 years, DFR will have no impact on FLXM…it will be confined to users in the UTM and ETM environments…where current ATC separation procedures don't exist. But, 10-15 years from now, all airspace users who choose to equip their aircraft with the necessary equipment, may be able to file flight plans under DFR. These flights will operate outside of the ATC system but will compete for the same airspace and will still be subject to TMI initiatives…and the means and procedures to do so remain to be seen. FLXM will need to be aware of DFR operations and be prepared to accommodate the differences in managing flow.

Specifically, under the NASA document (September 2022) referenced above…

Paragraph 4.3.4. Flight Dispatchers

An airline dispatcher that plans a DFR flight will have more flexibility to create optimal routes, not subject to the constraints of ATC preferred routes and enroute TMIs. They will be able to select optimal climb profiles, cruising altitudes, and wind- and weather-optimized routes to the terminal boundary arrival fix. Dispatchers will be able to leverage greater arrival-time predictability to reduce excess fuel load. Enroute changes created by the separation automation would be coordinated automatically between onboard and operations center computers, facilitating the dispatcher flight-following responsibility with reduced workload.

Dispatchers of UAS flights would have predictable access to more airspace without the need for approvals, waivers, or airspace reservations.