Aircraft Equipment Suffix Attachment
NASA DFRC 2007 Fire Mission
UAS COA Application Attachment

NASA Dryden Flight Research Center (DFRC) has procured from General Atomics – Aeronautical Systems Incorporated, an MQ-9 Reaper aircraft and a Ground Control Station (GCS). DFRC has assigned the number "NASA 870" to the aircraft and renamed it "Ikhana" (prounounced ee-kah-nah , a Native American word from the Choctaw Nation meaning intelligent, conscious, or aware).

It is unclear what the appropriate "aircraft suffix" is for the Ikhana aircraft. This attachment to the 2007 WSFM FAA COA application is intended to define the suffix that NASA-DFRC plans to use, and the rationale for using that suffix.

1. **Equipment Suffix** – For the 2007 WSFM flights, NASA DFRC will file a flight plan with the "/I" suffix.

   Rationale:
   1.1. The aircraft does not have DME, VOR, TACAN, or RVSM capabilities installed

   1.2. A TSO certified Mode C transponder is installed.

   1.3. Only the "Area Navigation (RNAV)", and "Advanced RNAV with Transponder and Mode C" groups are available (Ref. 2007 FAR/AIM Table 5-1-2 Aircraft Suffixes).

   1.4. The GCS does not have a native Flight Management System (FMS) built into the pilot workstation. An AC 120-76A compliant Electronic Flight Bag (EFB) software package (see below) is being added to an existing workstation in the GCS so the pilot will have current electronic IFR charts, electronic VFR charts and navigation database information during the mission. The EFB system will have, as a minimum, near real-time aircraft position updating.

   1.5. "/G" is not appropriate because GPS IFR terminal approach capability is not required (the aircraft is expected to take-off and land within Special Use Airspace (SUA) at Edwards, AFB, Ca, under VFR conditions, and no other nominal landing sites are planned).

   1.6. Pre-flight, the pilot will use the FAA RAIM prediction website to determine if there are any RAIM problems predicted. (http://www.raimprediction.net/ac90-100/)

   1.7. **Aircraft Avionics** - The avionics of the aircraft is designed with 3 flight computers, each with a dedicated GPS unit, and a dedicated INS unit (see below for identification). Additionally, the design includes an independent Honeywell Embedded GPS/INS (EGI) unit. There are 4 independent GPS antennas to feed satellite data to these units.

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| Deleted: <#>Because of the nature of the aircraft and the mission (high-flying at about ~100 KIAS, over TBD locations of wildfires), the "/G" capabilities of enroute navigation capability are not required. ¶ |
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1.7.1. The 3 flight computers share the four sources of NAV data (GPS/INS, GPS, and INS), which includes "quality indices" (assumed to be FOM, or similar), and the nav data with the highest quality is selected (voted) for flying the aircraft. This is expected to be the Honeywell H764 EGI.

1.7.2. If the data quality from the H-764 EGI is bad, or is lost altogether, the 3 flight computers use the remaining 3 dedicated GPS and INS systems and a mid-level voting scheme to select the data used to fly the aircraft. If additional failures or loss of GPS data quality occurs, a single leg of the triplex system would control the aircraft.

1.7.3. The Ku SatCom antenna uses only the Honeywell H-764 EGI data to maintain pointing to the Ku satellite in Geostationary orbit, so if the EGI data is lost or severely degraded, then the Ku command/telemetry link will probably be lost, and the aircraft will begin to execute the lost link mission.

1.7.4. The aircraft has a Raytheon APX-119 IFF Digital Transponder (TSO Certified to TSO-C112) installed with Mode C capability. Although this hardware also has Mode S capability, the software loaded in the aircraft/GCS is not able to utilize the Mode S capability (yet).

1.7.5. The aircraft has a Honeywell H-764 EGI (P/N CP34212889), 3 Honeywell HG1700 Inertial Measurement Units (IMU), and 3 NovAtel OEM4-G2 GPS cards installed.

1.8. **GCS Equipment and Capabilities** – The GCS capabilities are split into two categories, those that come with the manufacturers Pilot workstation, and those added by NASA – DFRC.

1.8.1. **Pilot workstation Capabilities** – The pilot workstation comes with a map display that displays real-time aircraft position. This system is not compliant to FAA requirements for a manned aircraft FMS, nor a manned aircraft EFB.

1.8.2. **NASA – DFRC Added Capabilities** – NASA-DFRC has added additional workstations to the GCS to perform various tasks necessary for scientific and research purposes. At least one of these workstations will provide navigational information to the pilot using software which meets AC 120-76A (such as ChartCase Professionsl from FlightPrep, Inc.). During the mission, this workstation will receive real-time, or near real-time aircraft position updating.

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References:

1. Federal Aviation Regulations/Aeronautical Information Manual (FAR/AIM) 2007 ASA-07-FR-AM-BK, © 2006 ASA, with current regulation as of August 3,2006, and AIM current through March 14, 2007.
2. AC-120-76A Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bag Computing Devices, 3/17/2003
3. TSO website: http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgtso.nsf/MainFrame?OpenFrameSet