Nominal Mission and Lost Link Procedures Description

NASA DFRC 2007 Fire Mission
UAS COA Application Attachment

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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" (pronounced ee-kah-nah , a Native American word from the Choctaw Nation meaning intelligent, conscious, or aware).

The NASA 2007 Western States Fire Mission (WSFM) flights will start and end at Edwards Air Force Base (EAFB) within the R-2508/R-2515 special use airspace (SUA). During these missions, there is no planned flight or maneuver in the National Air Space (NAS) below FL180 (Class A airspace).

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1. **NASA 2007 Western States Fire Mission (WSFM) Overview** –

The National Interagency Fire Center (NIFC) in Boise, Idaho is responsible for tracking and deciding appropriate responses to wildfires in the United States. To perform this function, NIFC requires information about where wildfires are, how big they are, and what the fires are doing. NIFC uses several sources to gather this information, including a small fleet of manned aircraft with infra-red (IR) imagers. The 2007 WSFM is designed to provide a demonstration to NIFC of a more capable IR imager on an unmanned aircraft. This demonstration will help NIFC determine whether upgraded imagers and unmanned aircraft will be useful tools in the future. Typically NIFC is tracking 300 – 500 active fires during any time during the western United States fire season.

The fire season for the western United States spans several months and a very large geographic region consisting of all or parts of 11 western states. Within this geographic region, wildfires can be located anywhere. To demonstrate the capability of the aircraft platform, the aircraft has to be able to fly to almost any location within this large geographic region. The unique endurance capabilities of unmanned aerial systems (UAS) may allow a single aircraft to gather imagery for NIFC on many different fires during a single mission.

Firefighter interest in wildfires revolves around "what will happen next". Imagery information can help answer this question best in two timeframes. The first timeframe is when the wildfire is newly discovered (will the wildfire grow?, will the wildfire threaten human population?). The second timeframe is for established fires that are near populations, when the imagery can help to answer the same questions.

Specific 2007 WSFM Objectives – The NIFC customer for the WSFM has the following objectives:

1.1. High altitude (FL410+) imaging with data transferred in near real-time to firefighters.
1.2. Imaging targets over the western United States. The fires can be anywhere and their precise location can not be predicted well.
1.3. 24 hour missions.
1.4. Image 10 to 15 wildfire incidents of the up to 500 that are burning at a time.
1.5. Image a few (1-2) fires for several hours at a time. Does not have to occur on every mission.
1.6. Identify or image emerging wildfires.
1.7. Provide some "high resolution data" from FL200. Identify small wildfire hotspots that are outside the primary burn area. These hotspots can flare-up unexpectedly and be very dangerous to firefighters and the general population. One mission is sufficient.

2. **WSFM COA Application Mission and Lost Link Procedure Attachments** - The following attachments are necessary to describe the NASA 2007 WSFM and are associated with this Nominal Mission and Lost Link Procedures description document:

2.1. NASA 2007 Fire Mission - Classes of Airspace
2.2. NASA 2007 Fire Mission – Regulations Requesting Waiver or Authorization

2.3. NASA 2007 Fire Mission - Outer Boundary for ABC 02-08-07.pdf (graphic)
2.4. NASA 2007 Fire Mission - Outer Boundary for ABC Coordinates 02-07-07, Formatted.doc (lat/lon points)

2.5. NASA 2007 Fire Mission - Zone ABC Keep Out 2006 02-12-07.pdf (graphic)

2.6. NASA 2006 Fire Mission - Coordinates and Dimensions of 2006 Keepouts 02-09-07.doc

2.7. NASA 2007 Fire Mission - Zone A 02-07-07 Coordinates.doc (lat/lon points)

2.8. NASA 2007 Fire Mission - Zone B 02-08-07 Coordinates.doc (lat/lon points)

2.9. NASA 2007 Fire Mission - Zone C 02-08-07 Coordinates.doc (lat/lon points)

2.10. NASA 2007 Fire Mission - Zone A - Route A 02-07-07.pdf (route/zone graphic)
2.11. NASA 2007 Fire Mission - Route A 02-01-07 Lat-Lon.doc (lat/lon points)
2.12. NASA 2007 Fire Mission - Route A North ifr hi alt 02-01-07.JPG (IFR chart)
2.13. NASA 2007 Fire Mission - Route A Central 2 ifr hi alt 02-01-07.JPG (IFR chart)
2.14. NASA 2007 Fire Mission - Route A South ifr hi alt 02-01-07.JPG (IFR chart)

2.15. NASA 2007 Fire Mission – Zone B – Route B 02-07-07.pdf (route/zone graphic)
2.16. NASA 2007 Fire Mission - Route B 02-01-07 Lat-Lon.doc (lat/lon points)
2.17. NASA 2007 Fire Mission - Route B ifr hi alt 02-06-07.JPG (IFR chart)

2.18. NASA 2007 Fire Mission - Zone C - Route C 02-07-07.pdf (route/zone graphic)
2.19. NASA 2007 Fire Mission - Route C 02-01-07 Lat-Lon.doc (lat/lon points)
2.20. NASA 2007 Fire Mission - Route C ifr hi alt 02-06-07.JPG (IFR Chart)

2.21. NASA 2007 Fire Mission – Aircraft Equipment Suffix Description.doc

2.22. NASA 2007 Fire Mission - Lost Link Datalink Recovery Flight Manual 21 Aug 2006 Figure 1-60.doc
2.23. NASA 2007 Fire Mission - Lost Link Aircraft Maneuvers Flight Manual 21 Aug 2006 Figure 1-61.doc

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3. **Number, Duration, and Timing of Flights** –
   3.1. A total of 5 flights are requested, each being between 24 and 30 hours in duration.
   3.2. Flights are planned to take-off on Thursdays and land on Friday because of the long duration, and the need to submit flight plans to FAA HQ UAS office before each flight. Thus, approximately 5 weeks will be required to fly all the missions.
   3.3. Because of wildfire emergencies (like the 2006 Esperanza fire), it is possible that NASA DFRC will be requested to fly more often than once per week, and possibly for more than 5 flights – these requests will be passed on to the FAA HQ UAS office as quickly as possible for consideration.

4. **Airspace** – For a description of the required Classes of Airspace, reference attachment: NASA 2007 Fire Mission - Classes of Airspace

5. **Regulations Requesting Waiver or Authorization** – For a listing of requested waivers to specific Part 91 sections, reference attachment: NASA 2007 Fire Mission – Regulations Requesting Waiver or Authorization.

6. **Flight Altitude –**

   6.1. All flight in the NAS shall be above FL180.

   6.2. **FL430** – 4 of the 5 flights will exit the R-2508 airspace at FL430, fly the entire mission at that altitude, and return into the R-2508 airspace at that altitude.

   6.3. **FL200** – 1 of the 5 flights will exit the R-2508 airspace at FL200, fly the entire mission at that altitude, and will return into the R-2508 airspace at that altitude. This mission will only be flown in Zone A, Route A. The FAA HQ UAS office will be notified of the date for this mission per the requirements in the "Flight Plan Submission" section.

7. **COA Region** (Overall COA boundary) – The overall COA boundary encompasses all of the forested parts of the western United States that the NIFC is interested in. This includes parts of 11 western states and 6 FAA ARTCC's. A graphical depiction of the overall COA boundary can be seen in Figure 1- Overall COA boundary below (Black hashed lines) and in the NASA 2007 Fire Mission - Outer Boundary for ABC 02-08-07.pdf attachment file.

   The COA boundary has been split into 3 zones along Air Route Traffic Control Center (ARTCC) boundaries. Each zone contains airspace controlled by no more than 3 ARTCC's. The Los Angeles Center ARTCC airspace is common to all 3 zones.

   7.1. A text version of the lat/lon coordinates (DD MM.MM and DD MM SS) for the overall COA boundary can be found in the attachment file NASA 2007 Fire Mission - Outer Boundary for ABC Coordinates 02-07-07.doc.

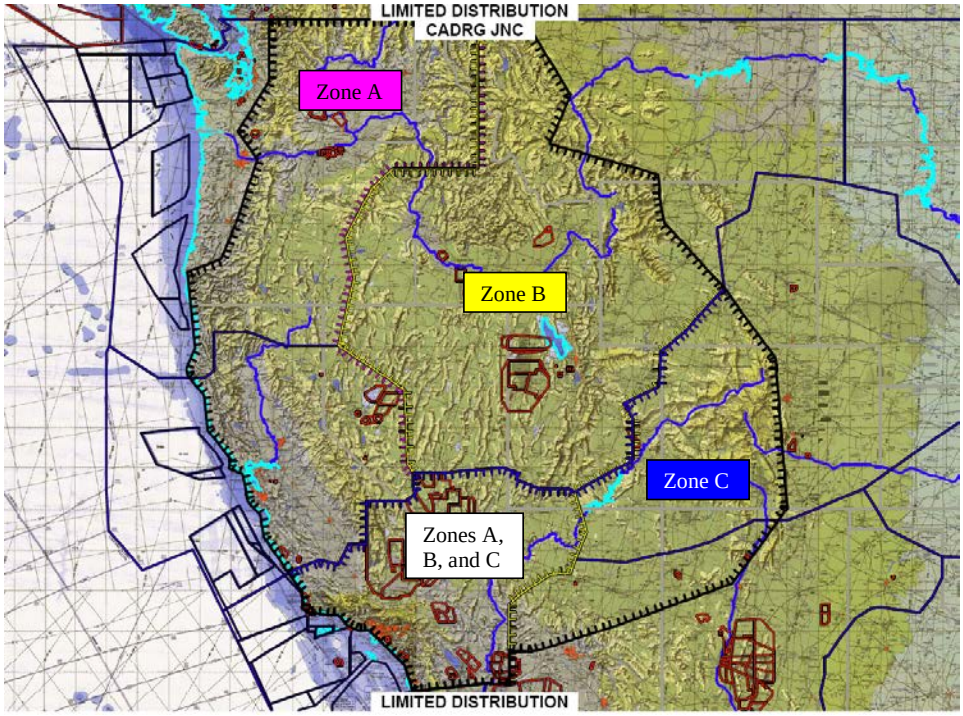

Figure 1 – Overall COA boundary

8. **Flight Zones** – The overall COA area was divided up into 3 zones for several reasons. First, the overall COA area is so big that the Ikhana aircraft does not have the endurance to fly a single flight over the entire COA region. Second, NASA DFRC recognizes that it will be a significant coordination effort on the part of the FAA HQ UAS office with the appropriate FAA centers to communicate our flight plan request.

   The area was divided into 3 zones based on the existing limits of FAA ARTCC's. Although the overall COA area includes parts of 6 ARTCC's, each single zone only includes a maximum of 3 ARTCC's. The resulting zones correspond reasonably well with the endurance capabilities of the aircraft, and provide some reduction of FAA HQ coordination for a flight plan submitted into a selected zone. Because flights will originate and terminate at Edwards AFB (EDW runway 22/04), California, the FAA Los Angeles ARTCC area is included in each of the 3 zones.

   A wildfire event that the NIFC wants imaged can be anywhere within the boundaries of a zone. It is recognized that within each zone, the aircraft must keep a 5 nm buffer zone to the edge of the zone/ARTCC boundary. The scan width of the imaging hardware (~12 nm at FL400+) on the aircraft will allow the aircraft to fly outside a 5

nm ARTCC boundary buffer and still image a wildfire that is on the zone/ARTCC boundary.

8.1. **Zone A** – Zone A contains Los Angeles Center, Oakland Center, and part of Seattle Center airspace. Zone A can be seen in "Pink" in Figure 1- Overall COA boundary (above), or in Figure 3 – Zone A – Route A Graphical description (also in attachment NASA 2007 Fire Mission - Zone A - Route A 02-07-07.pdf). Reference the NASA 2007 Fire Mission - Zone A 02-07-07 Coordinates.doc file for the specific lat/lon points that describe Zone A.

8.2. **Zone B** – Zone B contains Los Angeles Center, and part of Salt Lake City Center airspace. Zone B can be seen in "Yellow" in Figure 1- Overall COA boundary (above), or in Figure 4 – Zone B - Route B Graphical description (also in attachment NASA 2007 Fire Mission - Zone B - Route B 02-07-07.pdf). Reference the NASA 2007 Fire Mission - Zone B 02-08-07 Coordinates.doc file for the specific lat/lon points that describe Zone B.

8.3. **Zone C** – Zone C contains Los Angeles Center, part of Albuquerque Center and part of Denver Center airspace. Zone C can be seen in "Blue" in Figure 1- Overall COA boundary (above), or in Figure 5 – Zone C - Route C Graphical description (also in attachment NASA 2007 Fire Mission - Zone C - Route C 02-07-07.pdf). Reference the NASA 2007 Fire Mission - Zone C 02-08-07 Coordinates.doc file for the specific lat/lon points that describe Zone C.

9. **Range Safety Keep-out Zones and Population Centers –** The NASA DFRC Range Safety Office (DFRC-RSO) has defined a set of keep-out zones within the overall COA boundary area. These keep-out zones may or may not be divided up by Zone A, Zone B, or Zone C designations. The DFRC-RSO has determined that particular population densities must be protected to different degrees from the hazards of the aircraft flying over it.
   9.1. Route A, Route B, and Route C have been defined in cooperation with the DFRC-RSO and do not overfly any keep-out zones.
   9.2. The aircraft will not fly into any area that the DFRC-RSO has defined as a "Red" keep-out zone.
   9.3. The aircraft may fly into an area that the DFRC-RSO has defined as a "Yellow" (sometimes displayed as "white") keep-out zone, as long as the pilot has direct, real-time control of the aircraft. These keep-out zones may be displayed to the pilot in "white".
   9.4. The DFRC-RSO generated several hundred keep-out zones for the 2006 WSFM, and these are graphically displayed in Figure 2 2006 Keep-out Zones (graphic attachment file NASA 2007 Fire Mission - Zone ABC Keep Out 2006 02-12-07.pdf). The lat/lon. coordinates and attributes for each of these keep-out zones can be found in the attachment NASA 2006 Fire Mission - Coordinates and Dimensions of 2006 Keepouts 02-09-07.doc. Note: Figure 2 does not show any DFRC RSO keep-out zones for the west coast of California

between the Mexican border and San Francisco, and east to the central valley because this area was added to the 2007 WSFM COA boundary, but it was not in the 2007 WSFM COA boundary. This graphical representation and attribute file is provided with this COA Application to demonstrate to the FAA that NASA-DFRC is following DFRC Range Safety procedures on this subject. Because of the changing nature of the general population (increasing, decreasing, and moving), and the large size of the overall COA boundary, the DFRC-RSO will continue to analyze, modify, and refine the keep-out zones prior to each flight, and if necessary, during the flight to ensure proper protection for the general population. It is noted that the NIFC will probably have a high priority/interest to image wildfires that threaten population in areas that may be within previously defined keep-out zones. The DFRC-RSO will analyze these situations and modify keep-out zones and flight paths as necessary with the intent to protect the population, and at a lower priority, to obtain the desired imagery. This is the same process that was used during the 2006 Esperanza Fire mission.

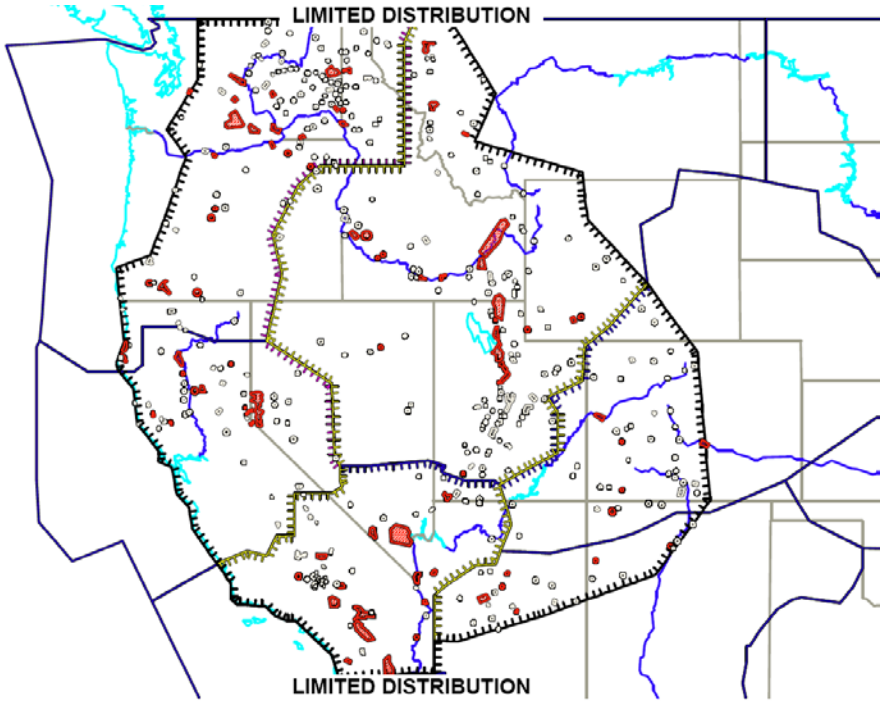

Figure 2 – 2006 Keep-out Zones (Red and Yellow/White)

9.5. The lost link mission may not be programmed to fly over a "Yellow" keep-out zone since the pilot does not have direct, real-time control of the aircraft.

9.6. During real-time maintenance of the lost link mission, the pilot will avoid putting the aircraft into a situation where it would overfly keep-out zones. The pilot will use the appropriate capabilities of the MQ-9 system to implement this, such as additional lost link waypoints and Initial Lost Link Heading (ILLH).

9.7. During flights, all keep-out zones will be displayed with current aircraft position to the pilot with the appropriate "Red" and "Yellow" designations, either by color or name.

9.8. A NASA DFRC Range Safety Officer will be present during all missions for any Range Safety consultations with the pilot that may be required.

10. **Flight Routes** – A "route" has been chosen for each flight zone for several reasons. First, the FAA needs to have a defined predictable route for the aircraft to coordinate a nominal flight plan for the aircraft. Second, the FAA needs to have a defined, predictable return route to the R-2508 Edwards AFB airspace for the aircraft if there is a "lost link" event. Third, the NASA DFRC Range Safety Organization (RSO) must ensure that the flight plan for the aircraft in the nominal and lost link scenarios mitigate any risk to the public.

    The defined routes provide an "out and back" "highway" (or hub) that the aircraft will depart from to fly to a particular wildfire location for imaging. The spoke routes (defined below) will depart from the highway route to lead directly to a wildfire location that needs to be imaged. The aircraft will take-off from Edwards AFB, follow the routes out to the fires, then turn around and follow those routes back to Edwards AFB for landing.

    Each of the routes have been analyzed and designed by the DFRC Range Safety Office to not overfly population centers they have identified (see the section on Keep-out Zones).

    These basic flight routes are named "Route A", "Route B", and "Route C" to correspond to Zone A, Zone B, and Zone C.

    10.1. **Route A** – Route A is designed to fly over generally unpopulated mountainous terrain of the Sierra Nevada mountain range. See Figure 3 – Zone A, Route A Graphical Description (also in attachment NASA 2007 Fire Mission - Zone A - Route A 02-07-07.pdf).

        10.1.1. Reference the NASA 2007 Fire Mission - Route A 02-01-07 Lat-Lon.doc file for the specific lat/lon points that describe Route A. Reference the NASA 2007 Fire Mission - Route A (North, Central, South) ifr hi alt 02-01-07.JPG (IFR chart) for graphic representations of Route A on a typical high altitude IFR chart.

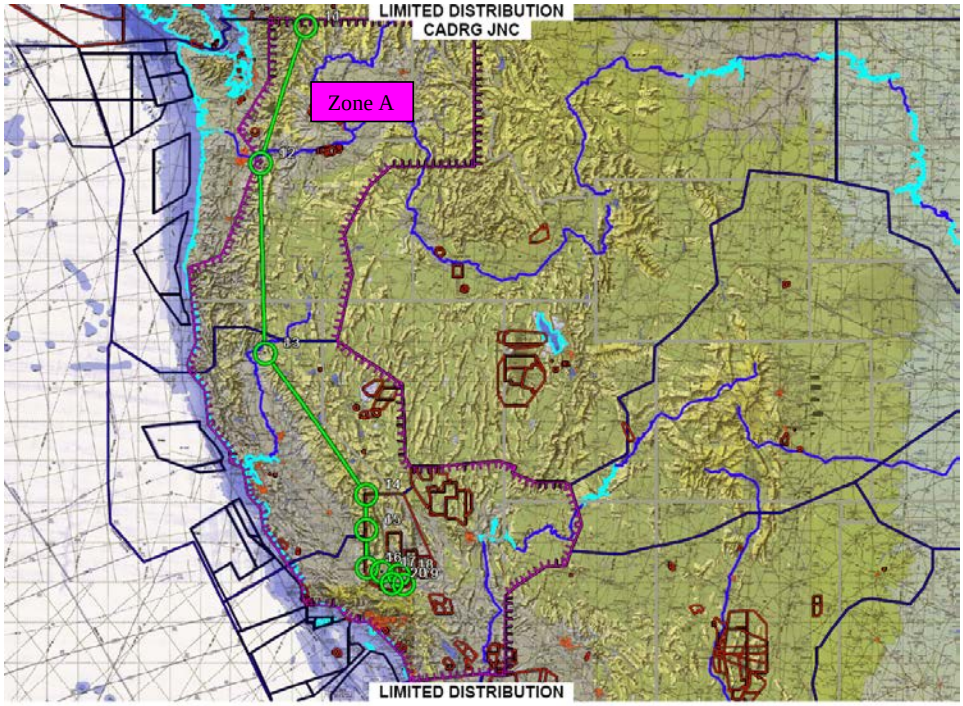

Figure 3 – Zone A - Route A Graphical description

10.2. **Route B** – Route B differs from the other 2 routes since it is essentially a "loop". See Figure 4 – Zone B, Route B Graphical Description (also in attachment NASA 2007 Fire Mission - Zone B - Route B 02-07-07.pdf).

10.2.1. Depending on the wildfire imaging requirements and priorities from NIFC, the filed flight plan may request to fly this loop forward or backward, or to only fly one side of the loop (there and back) because the aircraft may not have the endurance to traverse the entire loop. The pilots will adjust the lost link profile accordingly, and will include the logic for the aircraft to fly "forward around the loop" in case of a lost link event after the halfway point.

10.2.2. Reference the NASA 2007 Fire Mission - Route B 02-01-07 Lat-Lon.doc file for the specific lat/lon points that describe Route B. Reference the NASA 2007 Fire Mission - Route B ifr hi alt 02-06-07.JPG file for a graphic representation of Route B on a typical high altitude IFR chart.

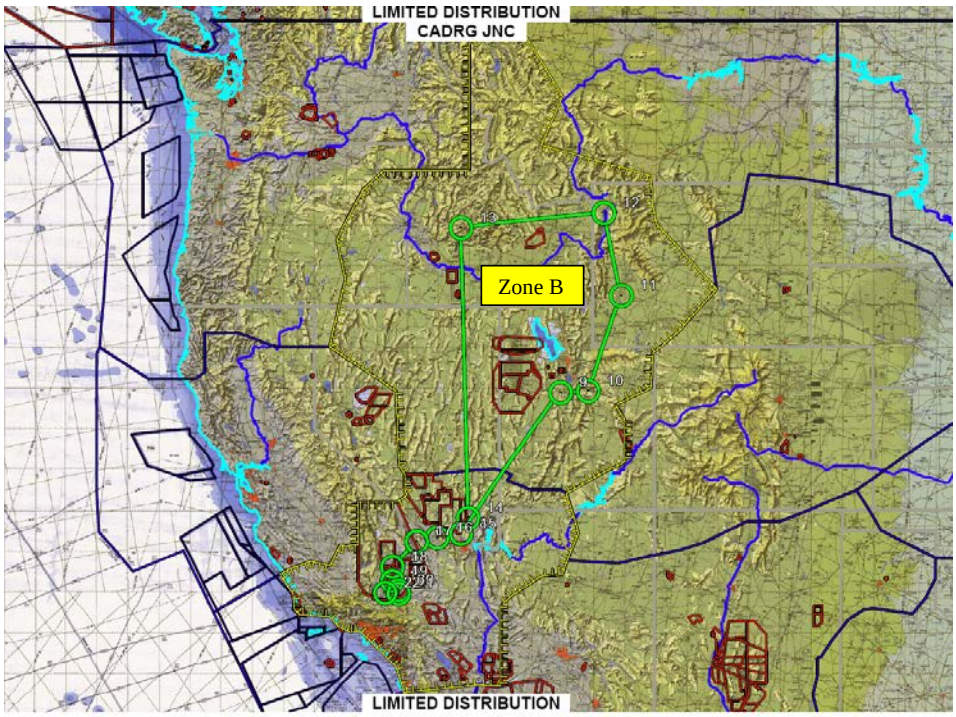

Figure 4 – Zone B - Route B Graphical description

10.3. **Route C** – See Figure 5 – Zone C - Route C Graphical Description (also in attachment NASA 2007 Fire Mission - Zone C - Route C 02-07-07.pdf).

10.3.1. Reference the NASA 2007 Fire Mission - Route C 02-01-07 Lat-Lon.doc file for the specific lat/lon points that describe Route C. Reference the NASA 2007 Fire Mission - Route C ifr hi alt 02-06-07.JPG file for a graphic representation of Route C on a typical high altitude IFR chart.

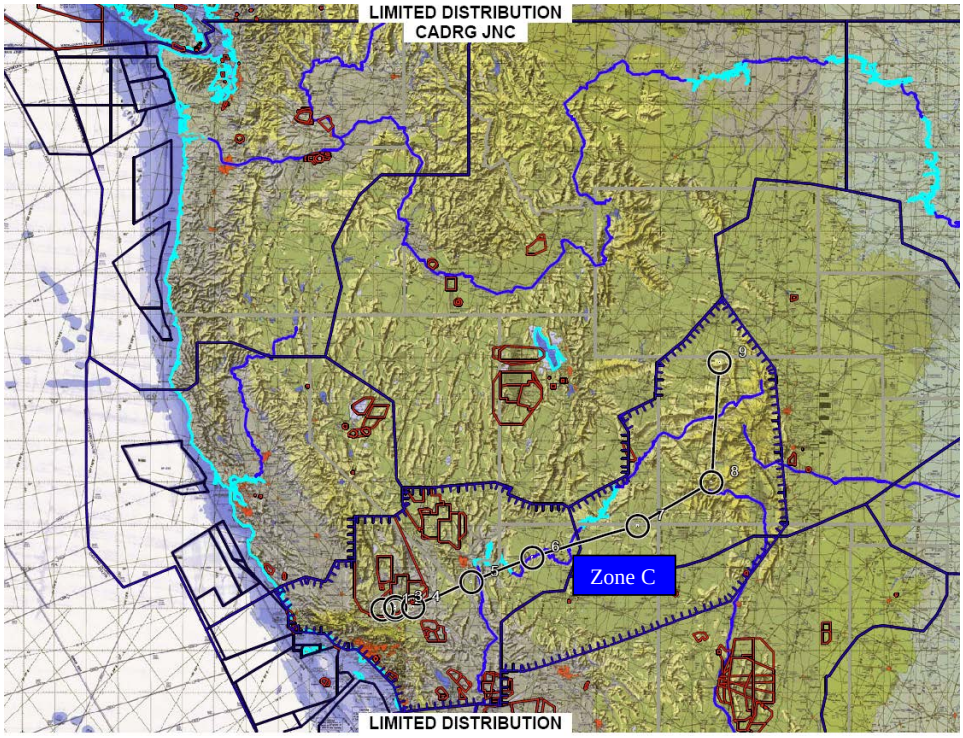

Figure 5 – Zone C - Route C Graphical description

11. **"Spoke" Routes to the Wildfire Incidents –** Spoke routes will be defined by NASA DFRC that branch out from the defined Routes and go out to the NIFC wildfire incident areas. The aircraft will follow the spoke routes when transiting between the defined Routes and the wildfire incident areas when under nominal pilot control, and in lost link situations.
    - 11.1. If two wildfire incident areas are relatively close together, but relatively far from the defined Routes, a "daisy-chained" spoke route may be created that traverses from one incident area to another, without first returning to the predefined route. See Figure 6 – Spoke Routes for a representative example.
    - 11.2. Use of daisy-chained spoke routes will be minimized and will not be used to circumvent the intent of the defined Routes.
    - 11.3. Any use of daisy-chained spokes will require the lost link mission to retrace the spokes back to the defined Route.
    - 11.4. All spoke routes will be reviewed and analyzed by the NASA DFRC Range Safety Office for risk to the public.
    - 11.5. Spoke routes will be submitted to the FAA HQ UAS office on the timeline described in the "Flight Plan Submission" section.
    - 11.6. Based on NIFC requirements, there are expected to be between ~5 and ~15 spoke routes per mission.

11.7. The spoke routes will branch out from the Routes in a manner that reduces the distance between the defined Routes and the incident areas and is still compatible with the priorities of the mission and aircraft endurance (the intent is to make the spokes as 90 deg to the route as practical, but not to force a 90 degree departure from the defined Route at all times).

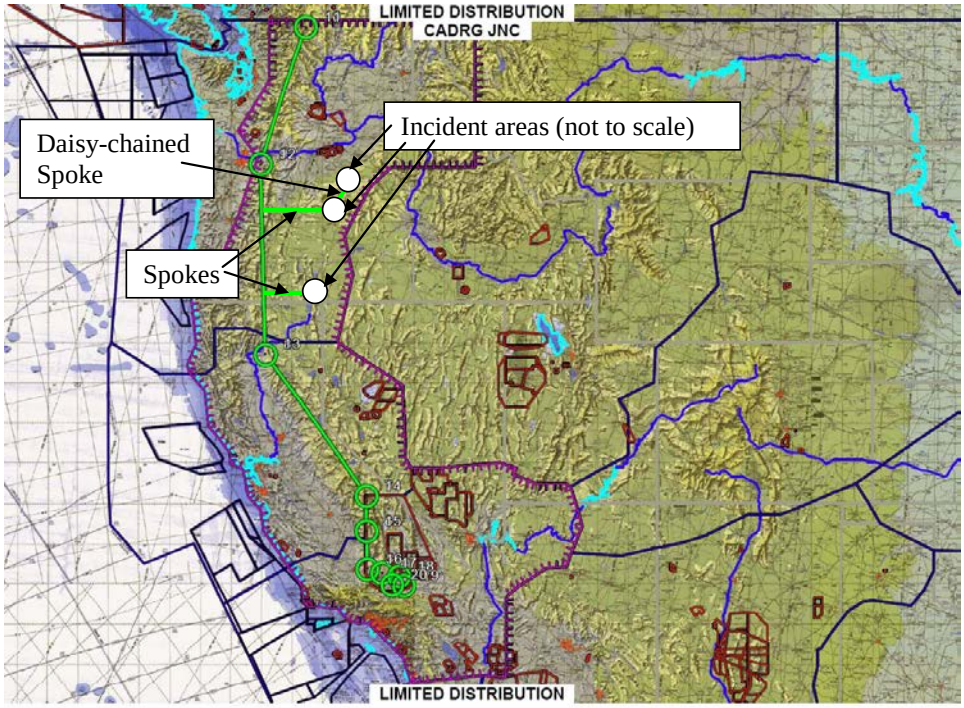

Figure 6 – Spoke Routes

12. **Incident Areas –** Incident areas will be defined by NASA DFRC that encompass a large enough airspace so that the IR imager on the aircraft can obtain appropriate data on the wildfire that NIFC has identified. In most cases, the IR imager will be able to obtain the data in 1 or 2 passes (swaths).
    12.1. The shape of each incident area will be determined by the particular wildfire event it is meant to image. Simple circles and rectangles are expected in most cases.
    12.2. The size of each incident area will be large enough so that the aircraft can perform the required turns to exit the area back to the spoke, perform any additional passes required to fully image the wildfire, and have a sufficient buffer for a lost link event to provide a predictable path to ATC and ensure the aircraft will not "spillout" from the incident area.

12.3. For large wildfires that require multiple passes, the incident areas will be defined large enough for the aircraft to complete a complete set of imaging swaths.
12.4. The preferred method of defining incident areas to the FAA is via a radial/DME point and a specified radius from that point. A secondary means is via lat/lon points that describe the shape.
12.5. 10 to 15 incident areas are expected for each mission.
12.6. At FL400+, the Ikhana aircraft has about a 5 nm turning radius. For the FL200 mission, the turning radius is about 2.5 nm.

13. **Flight Plan Submission** –
13.1. The flight plan will be submitted with a "/I" Aircraft equipment suffix per the rationale contained in the attachment: NASA 2007 Fire Mission – Aircraft Equipment Suffix Description.
13.2. NASA DFRC will provide the FAA HQ UAS office with flight plan proposals by the prescribed times and will take into account the time zone difference between Washington, DC and Edwards, Ca.
13.3. The FAA HQ UAS office has the authority to accept or reject all, or any portion of the NASA DFRC flight plan proposals.
13.4. In the event that all or parts of a proposal are to be rejected, both organization will attempt to find a workable solution for both organizations.

13.5. NLT L – 3 work days: NASA DFRC will notify the FAA HQ UAS office of a proposed Zone/Route combination. Included with the proposal will be mission altitude (FL430/FL200) and all planned spokes, daisy-chained spokes, and incident areas. 10 to 15 incident areas are expected to be in each proposal.
13.6. NLT L – 1 work day: NASA DFRC will notify the FAA HQ UAS office of there are any proposed changes to the Zone/Route combination, and describe those proposed changes. Included with the proposed changes will be all proposed changes to spokes, daisy-chained spokes, incident areas, and lost link mission routing (see description under "Route" section).
13.7. NLT L – 2 hours: NASA DFRC will file the flight plan per normal procedures with the Edwards, AFB, Ca Operations office.

13.8. Definitions for flight plan Submission.
13.8.1. NLT: No later Than
13.8.2. L – 3 work days: 72 hours prior to take-off time, not including Saturday, nor Sunday.
13.8.3. L – 1 work day: 24 hours prior to take-off time, not including Saturday, nor Sunday.

14. **Lost Link Procedures –** The overriding concern in any lost link situation is to maintain the safety of the NAS for other aircraft. The aircraft is designed by General Atomics to perform several operations automatically.

    14.1. **Automatic MQ-9 Lost Link Responses –** The aircraft is designed to perform two tasks automatically when the aircraft detects a lost command link situation.

        14.1.1. **Regain the Command Link –** The aircraft will automatically perform actions with the onboard communications system to maximize the probability that the command/Datalink will be recovered. Reference attachment NASA 2007 Fire Mission - Lost Link Datalink Recovery Flight Manual 21 Aug 2006 Figure 1-60.doc

        14.1.2. **Aircraft Maneuvers –** The aircraft will automatically perform specified actions with respect to aircraft maneuvers in the event of a loss of command link. Reference attachment NASA 2007 Fire Mission - Lost Link Aircraft Maneuvers Flight Manual 21 Aug 2006 Figure 1-61.doc. The pilot also maintains a "lost link" mission in real-time to direct the aircraft as a part of this process.

    14.2. **2007 WSFM Specific Lost Link Procedures –** The aircraft needs to have a lost link mission defined for the aircraft to perform as expected during a lost link situation.

        14.2.1. The pilot will define and maintain a lost link mission throughout the flight that returns the aircraft to R-2508 and Edwards, AFB.
        14.2.2. The lost link mission will be defined to return to R-2508 along the defined Route and spoke the aircraft is currently on.
        14.2.3. The lost link mission will be programmed to squawk 7600 (per FAA HQ UAS office request) whenever the aircraft enters the lost link mission.
        14.2.4. In the event of a lost link situation, the pilot will contact the appropriate FAA ATC facility supervisor to notify them of the situation. The pilot and appropriate FAA ATC facility supervisor(s) shall remain in phone contact throughout the lost link situation (this may involve several FAA ARTCC's, depending on the location of the aircraft when it enters the lost link mission.)
        14.2.5. Predictable flight path in lost link. The lost link "entry waypoint" will be managed by the pilot so the aircraft performs as follows. Reference Figure 7 – Original and Offset/Detour Route Change.
            14.2.5.1. The aircraft will proceed on an existing course for at least ~2 min until ATC can be informed by phone, and then ATC can take appropriate actions with other aircraft to ensure aircraft separation.
            14.2.5.2. If a lost link event occurs less than ~2 min from a planned turning point, the aircraft will be programmed to make the turn in the lost link mission and thus to stay on the prescribed route. The aircraft

will make any required turn back to base while on the prescribed route.

14.2.6. If the aircraft recovers a command link from the GCS, and the cause of the lost link event is well understood and can be prevented during the remainder of the mission, the mission is not required to return to R-2508 and Edwards, AFB, but may proceed as planned.

14.2.7. The pilot will manage the Initial lost link altitude (ILLA) so that the aircraft is always flying above the ILLA. This bypasses any attempt for the aircraft to climb during the initial part of a lost link event, and ensures begins to execute the lost link mission in <1 second. Reference attachment: NASA 2007 Fire Mission - Lost Link Aircraft Maneuvers Flight Manual 21 Aug 2006 Figure 1-61.doc

14.3. **Lost Link while on a Route** – The overriding concern in any lost link situation is to maintain the safety of the NAS for other aircraft. Normally this is done by programming the aircraft to proceed on an existing course, or route, for several minutes until ATC can be informed by phone, and then ATC can take appropriate actions with other aircraft to ensure aircraft separation.

14.3.1. The aircraft will maintain the defined Route for ~2 min after a lost link event before proceeding back to R-2508 and Edwards AFB, Ca. on the prescribed route.

14.3.2. During the ~2 minute timeframe at the beginning of the lost link event, the aircraft may make turns to stay on the defined Route.

14.3.3. While in lost link, the aircraft may or may not have to make a 180° on the Route to proceed to R-2508 and Edwards AFB, Ca. (i.e. it may be headed away from, or towards R-2508 when the lost link event occurs).

14.4. **Lost link while on a spoke or daisy-chained spoke –** The overriding concern in any lost link situation is to maintain the safety of the NAS for other aircraft. Normally this is done by programming the aircraft to proceed on an existing course, or route, for several minutes until ATC can be informed by phone, and then ATC can take appropriate actions with other aircraft to ensure aircraft separation.

14.4.1. The aircraft will maintain the defined spoke or daisy-chained spoke for ~2 min after a lost link event before proceeding back to R-2508 and Edwards AFB, Ca. on the prescribed route.

14.4.2. While in lost link, the aircraft may or may not have to make a 180° on the spoke to proceed to R-2508 and Edwards AFB, Ca. (i.e. it may be headed away from, or towards R-2508 when the lost link event occurs).

14.5. **Lost link within an Incident Area** –Within an incident area, the Ikhana aircraft could be making multiple passes over a fire that requires several 90°, 180°, and 270° turns. If the pilot attempts to keep the lost link mission updated during these turns so that the aircraft will continue the turn (or to straighten out on the heading the aircraft happens to be on), pilot workload can become overwhelming. Another option is for the incident areas to be

made large enough so the aircraft could fly ~2 min in any direction from the planned route and stay within the incident area. This options could increase the size of the incident areas to such a degree that they would unnecessarily interfere with other NAS traffic. A compromise between these two methods is proposed below.

14.5.1. During lost link within an incident area, the aircraft will stay within the incident area boundaries for at least ~2 min.

14.6. **Route, Lost Link and Incident Area Proposed Changes at L-1 days** – Changes to a route and associated lost link mission will follow the following rules. See Figure 7 – Original and Offset/Detour Route Change.

14.6.1. Any route change will be an offset/detour that stays within 15 nm of the original route.

14.6.2. The offset/detour route will also become the lost link route, and the aircraft will not be programmed to fly on the original route in the area of offset/detour.

14.6.3. If a lost link event occurs near a planned turning point, the aircraft will still be programmed to make the turn within the lost link mission to stay on the route.

14.6.4. Changes to Incident Areas will follow these rules:

14.6.4.1. Changes, and additions to the Incident areas will keep the aircraft within 25 nm of the original route.

14.6.4.2. Any Incident areas can be deleted. Appropriate spokes or daisy-chained spokes can also be deleted.

14.6.4.3. Appropriate spoke or daisy-chained spokes will be added as necessary.

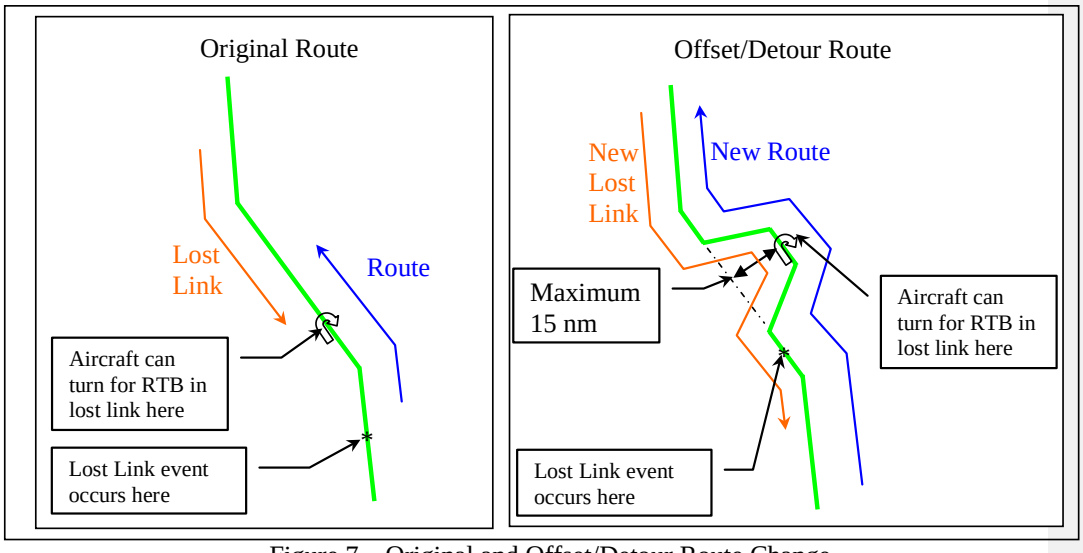

Figure 7 – Original and Offset/Detour Route Change

15. **Typical Flight Profile -** The typical flight profile will consist of the following.

15.1. Within R-2508 airspace (Edwards, AFB, Ca.)
15.1.1. Take-off from EDW 22/04
15.1.2. Climb to mission altitude (FL200 or FL430)
15.1.3. Transit to R-2508 boundary (Route A, B, or C)

15.2. Enter NAS at R-2508 boundary (Route A, B, or C)
15.2.1. Follow Route until first Spoke
15.2.2. Turn on Spoke to Incident Area
15.2.3. Image wildfire in Incident Area
Typically will image 10-15 Incident Areas each mission. Usually 1-3 passes imaging passes totaling <30 minutes in each area. Downlink imagery data to NIFC in near real-time. Some wildfires may be imaged in the outbound and return directions.
15.2.4. Return to Route via Spoke
15.2.5. Proceed to next Spoke (next spoke may be back in the direction of Edwards AFB, Ca.)
15.2.6. Repeat above steps until last Incident Area is imaged
15.2.7. Return to Route via Spoke

15.3. Enter R-2508 at NAS boundary (Route A, B, or C)
15.3.1. Descend from mission altitude
15.3.2. Land at EDW 22/04

16. **Glossary** -

Daisy-chained Spoke - A spoke that connects two incident areas
Incident Areas – Area the contains a NIFC defined wildfire event underneath.
NIFC - National Interagency Fire Center. Located in Boise, Idaho. Members include: Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), Fish and Wildlife Service (FWS), National Park Service (NPS), United States Forest Service (USFS), National Oceanic and Atmospheric Administration (NOAA), Department of the Interior – Aviation Management Directorate (AMD), National Association of State Foresters (NASF), and the United States Fire Administration (USFA).
Overall COA Boundary – Boundary authorized by the COA that includes Zones A, B, and C.
Pilot – Pilot-in-Command (PIC)
Route - Defined flight paths within each Zone

Spoke - Defined flight paths within a zone between the defined Route and Incident Area.
Zone - Subset of the overall boundary authorized by the COA.