MQ-1 Ground Observer Capability Demonstration

26 Aug 2008

Purpose: Two MQ-1 ground observer capability demonstrations were conducted to determine if Ground Observers could maintain visual line-of-sight with an actual MQ-1 and an aircraft similar in size and characteristics of an MQ-1 while also scanning the environment for potential conflicting traffic. The results of these demonstrations will be used to determine ground observer capability in a corridor from Cannon AFB to R-5104A for both day and night operations and documented in a safety case by AFSOC/SE.

Background: Several documents cover operating unmanned aircraft in the National Airspace System (NAS). One of the main documents that the FAA uses to determine if unmanned aircraft are allowed to operate within the NAS is the FAA Aviation Safety Unmanned Aircraft Program Office Interim Operational Approval Guidance (UAPO 08-01). The Observer Capability Demonstration concentrated on two areas:

(1) Establish an optimum vertical and lateral distance where the ground observers can maintain visual contact with an aircraft that is similar in size and speed of an MQ-1 unmanned aircraft at all times while scanning the immediate environment for potential conflicting traffic during day time hours.

(2) Determine if ground observers can maintain visual contact with an aircraft that is similar in size and speed of an MQ-1 unmanned aircraft at all times while scanning the immediate environment for potential conflicting traffic during nighttime hours.

During the demonstration, observers were permitted to use binoculars, however, only to augment the observer's visual capability and could not be used as the primary means of visual contact. During night ops, ground observers were in place 1-hour prior to the start of the demonstration.

Results:

First demonstration; Creech AFB 24 Jul 08; 0930L – 1230L (MST). Weather reported during the demonstration was: "Sky clear, visibility 10 SM with considerable haze, wind 050/3, and temperature 89 F. Ground observers were placed at the control tower (position #1) and approximately ½ mile East of the control tower (position #2). The MQ-1 was observed while flying within the local tower pattern including an outside downwind. The demonstration could only be conducted during daylight hours. The results were as follows:

Position #1

Altitude	Max usable visual deconfliction distance
1500' AGL	2.0 NMs
2000' AGL	2.5 NMs
2500' AGL	2.0 NMs

3000’ AGL	2.5 NMs
4000’ AGL	2.5 NMs

Position #2

Altitude	Max usable visual deconfliction distance
1500’ AGL	2.0 NMs
2000’ AGL	2.5 NMs
2500’ AGL	2.5 NMs
3000’ AGL	3.0 NMs
4000’ AGL	3.0 NMs

The terrain around Creech has mountains that the MQ-1 has as a backdrop during portions flown of the tower pattern. These mountains made it difficult to maintain visual on the MQ-1.

Second demonstration; Cannon AFB; 30 Jul 08; 1400L – 1555L (MST) “Daytime” flight. Weather reported during the day demonstration was: “Sky FEW 100 FEW 170, visibility 10 SM, wind VRB/4, and temperature 91 F. Ground observers were placed at four different locations with 4 NMs separation between each observer (see figure 1). Observer # 4 had to be moved to the location indicated with a green circle due to unavailable access to the original site. Two aircraft were used during the demonstration. A C-172 was used to represent the MQ-1 since it is similar in size. The pilot flew at 75 KIAS to replicate the MQ-1 cruise airspeed. A second aircraft, Mooney 20 was used as a conflict aircraft. The C-172 flew the corridor (indicated in blue on figure 1) at four altitudes; 1000’ AGL, 2000’ AGL, 3000’ AGL and 4000’ AGL. The Mooney acted as conflicting traffic and crossed the corridor at random intervals during the demonstration. Cannon Radar Approach Control was able to monitor both aircraft and documented the position of the conflicting traffic throughout the demonstration. The results were as follows:

Observer position #2

Altitude	Max visual distance	Max usable visual deconfliction distance
1000’ AGL	2.0 NMs	2.0 NMs
2000’ AGL	2.5 NMs	2.0 NMs
3000’ AGL	4.0 NMs	2.5 NMs
4000’ AGL	4.0 NMs	2.5 NMs

Observer position #3

Altitude	Max visual distance	Max usable visual deconfliction distance
1000’ AGL	3.5 NMs	2.5 NMs
2000’ AGL	3.5 NMs	2.5 NMs
3000’ AGL	3.5 NMs	2.5 NMs

4000’ AGL	3.5 NMs	2.5 NMs

Observer position #4

Altitude	Max visual distance	Max usable visual deconfliction distance
1000’ AGL	4.0 NMs	2.5 NMs
2000’ AGL	4.0 NMs	3.0 NMs
3000’ AGL	4.5 NMs	3.0 NMs
4000’ AGL	4.5 NMs	3.0 NMs

Observer position #5

Altitude	Max visual distance	Max usable visual deconfliction distance
1000’ AGL	3.0 NMs	2.5 NMs
2000’ AGL	3.0 NMs	2.5 NMs
3000’ AGL	4.0 NMs	3.0 NMs
4000’ AGL	4.0 NMs	3.0 NMs

Third demonstration; Cannon AFB; 30 Jul 08; 2130L – 2220 (MST) “Nightime” flight. Weather reported during the day demonstration was: 2130L “Sky FEW 100 BKN 150, visibility 7 SM, wind 110/4, and temperature 82 F. At 2215L “Sky BKN 170, visibility 10 SM, wind 180/7, and temperature 79 F. Ground observers were placed at three different locations (observer # 2, #3 and #4 locations) with 4 NMs separation between each observer (see figure 1). Observer # 4 had to be moved to the location indicated with a green circle due to unavailable access to the original site. Two aircraft were used during the demonstration. A C-172 was used to represent the MQ-1 since it is similar in size. The pilot flew at 75 KIAS to replicate the MQ-1 cruise airspeed. A second aircraft, also a C-172 was used as a conflict aircraft. The C-172 flew the corridor (indicated in blue on figure 1) at two altitudes; 3000’ AGL and 4000’ AGL. The second C-172 acted as conflicting traffic and crossed the corridor at random intervals during the demonstration. Cannon Radar Approach Control was able to monitor both aircraft and documented the position of the conflicting traffic throughout the demonstration. Ground observers were in place one-hour prior to start of the demonstration to acclimate their eyes. Two observers were used at each site; one observer wore Night Vision Devices (NVDs) and the other used only their unaided eye sight. The results were as follows:

Observer position #2 (With NVDs)

Altitude	Max visual distance	Max usable visual deconfliction distance
3000’ AGL	at least 15 NMs	2.5 NMs
4000’ AGL	at least 15 NMs	2.5 NMs

Observer position #2 (Unaided eye-sight)

Altitude	Max visual distance	Max usable visual deconfliction distance

3000’ AGL	14 NMs	3.0 NMs
4000’ AGL	14 NMs	3.0 NMs

Observer position #3 (With NVDs)

Altitude	Max visual distance	Max usable visual deconfliction distance
3000’ AGL	at least 15 NMs	2.5 NMs
4000’ AGL	at least 15 NMs	2.5 NMs

Observer position #3 (Unaided eye-sight)

Altitude	Max visual distance	Max usable visual deconfliction distance
3000’ AGL	at least 15 NMs	2.5 NMs
4000’ AGL	at least 15 NMs	2.5 NMs

Observer position #4 (With NVDs)

Altitude	Max visual distance	Max usable visual deconfliction distance
3000’ AGL	Not usable due to car lights	
4000’ AGL	Not usable due to car lights	

Observer position #4 (Unaided eye-sight)

Altitude	Max visual distance	Max usable visual deconfliction distance
3000’ AGL	13 NMs	2.5 NMs
4000’ AGL	13 NMs	2.5 NMs

Objectives: The following were the objectives of the demonstration with the results.

1. Validate that ground observers can access observer locations 2-5. Observer location #1 is the ATC tower and is no issue.

   All ground observer positions except for #4 were accessible. Position #4 had to be moved further north to a position on the north side of SR 60.

2. Validate that ground observers can detect an aircraft that is similar in size and performance of the MQ-1 at a distance of at least 2 NMs laterally from each ground observer site (both day and night) within the defined corridor.

   Average max visibility capability during daylight hours at Cannon was 3.6 NMs. Nighttime max visibility was 13 NMs with unaided capability. Average max visibility during daylight hours at Creech was 2.45 NMs.

3. Validate ground observers can detect an aircraft similar in size and performance of the MQ-1 at 3000' AGL (7500' MSL) vertically within the defined corridor (both day and night).

   3000' and 4000' AGL gave the greatest visibility distance at both Creech and Cannon demonstrations.

4. Determine if ground observers can detect an aircraft similar in size and performance of the MQ-1 at 4000' AGL (8500' MSL) vertically within the defined corridor (both day and night).

   See Objective #3.

5. Validate ground observers can detect "other" aircraft in the vicinity of the MQ-1 aircraft at various stages of flight.

   Average max usable visual deconfliction distance for 3000' and 4000' AGL during daylight hours was 2.75 NMs.

6. Validate each ground observer can communicate to the pilot (data recorder) from each ground observer location.

   Communication used during the demonstration was unacceptable (older radios were used). Communication site survey must be accomplished to determine best communication capability. **PRC-117F would probably work best.**

Recommendations: The following are recommendations as a result of the demonstrations.

- Move the corridor further to the north placing the MQ-1 flight path closer to observer #4 (had to be offset due to inaccessible original location; see figure 2).

- Add a holding pattern in Cannon Class D and a Holding pattern in R-5104A (see figure 2). Allows the MQ-1 to use their IR cameras to scan the corridor for potential traffic prior to being cleared to enter the corridor. Allows RAPCON to scan for primary and secondary targets. Only after observers, RAPCON, and MQ-1 sensor reports no traffic will the MQ-1 be permitted to enter the corridor.

- Establish a 20 X 20 NM clear zone box (see figure 3). RAPCON would ensure that only aircraft that they have communications with are in the box prior to clearing the MQ-1 in the corridor.

- Consider dedicating a controller in the RAPCON with a dedicated radar display to monitor/control the MQ-1 from takeoff to entry in R-5104A and same on return (approximately 30 minutes).

- Establish ground visual cues so that the ground observers can easily identify where the MQ-1 would be when they report their position in the corridor.

- Include in the 3 SOS CONOPs observer-to-observer handoff procedures and responsibilities.

- Develop an observer training program that includes handoff procedures.

- Consider purchasing anti-glare sunglasses for observers.

- 27 SOW conduct a communication survey to determine best communication.

Conclusion:

The terrain at Cannon AFB is basically flat with none of the mountainous issues encountered at Creech AFB. The demonstrations proved that using ground observers to deconflict potential non-participating aircraft/objects with the MQ-1 flying from Cannon AFB to R-5104A is feasible. Coupled with other risk mitigation, this operation could take place safely with no harm to personnel on the ground or in the air.

Observer Locations

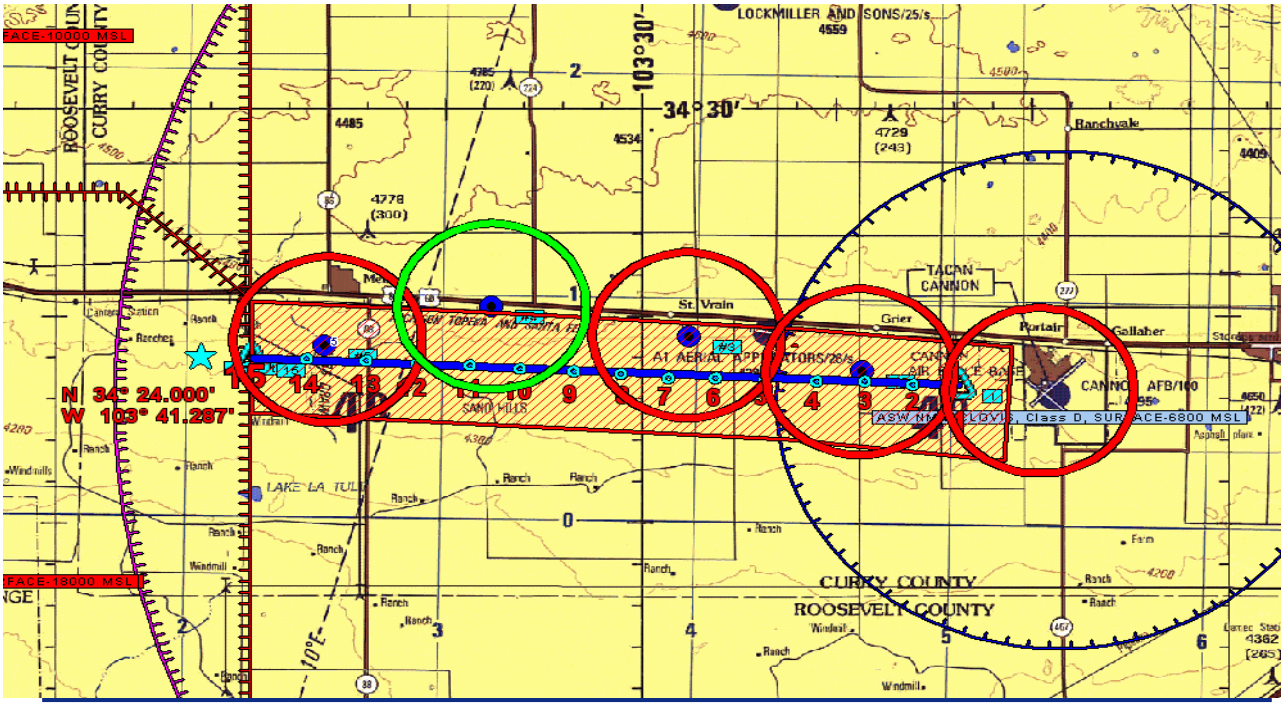

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Figure 1. Ground Observer Locations During Cannon Demonstration; 2 nm Radius Circles.

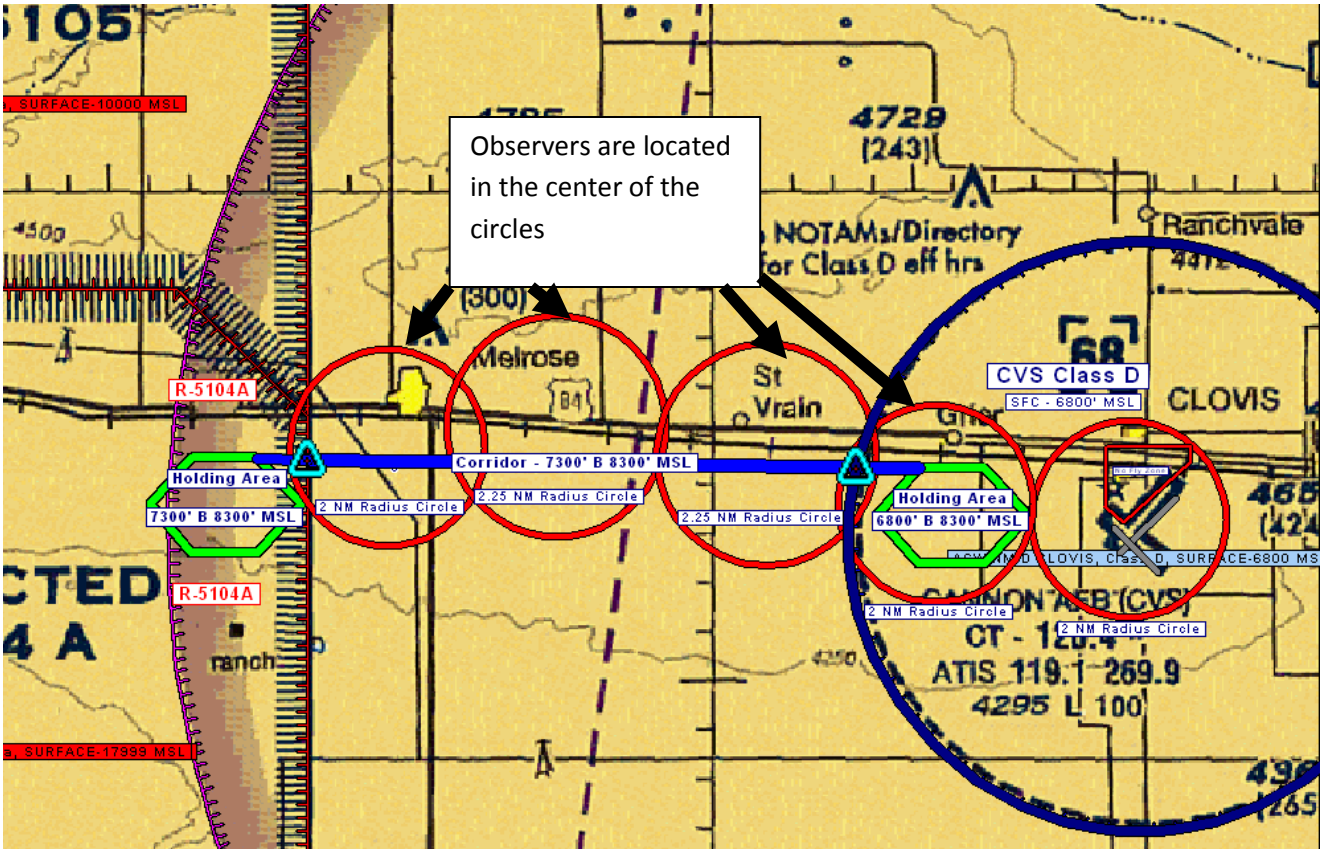

Figure 2. Proposed corridor with holding patterns and observer locations. Note: Increased observer # 3 and #4 to 2.25 NM radius, others remain at 2.0 NM radius and moved corridor to the North. Corridor altitude; 3000’ – 4000’ AGL (7300’ – 8300’ MSL).

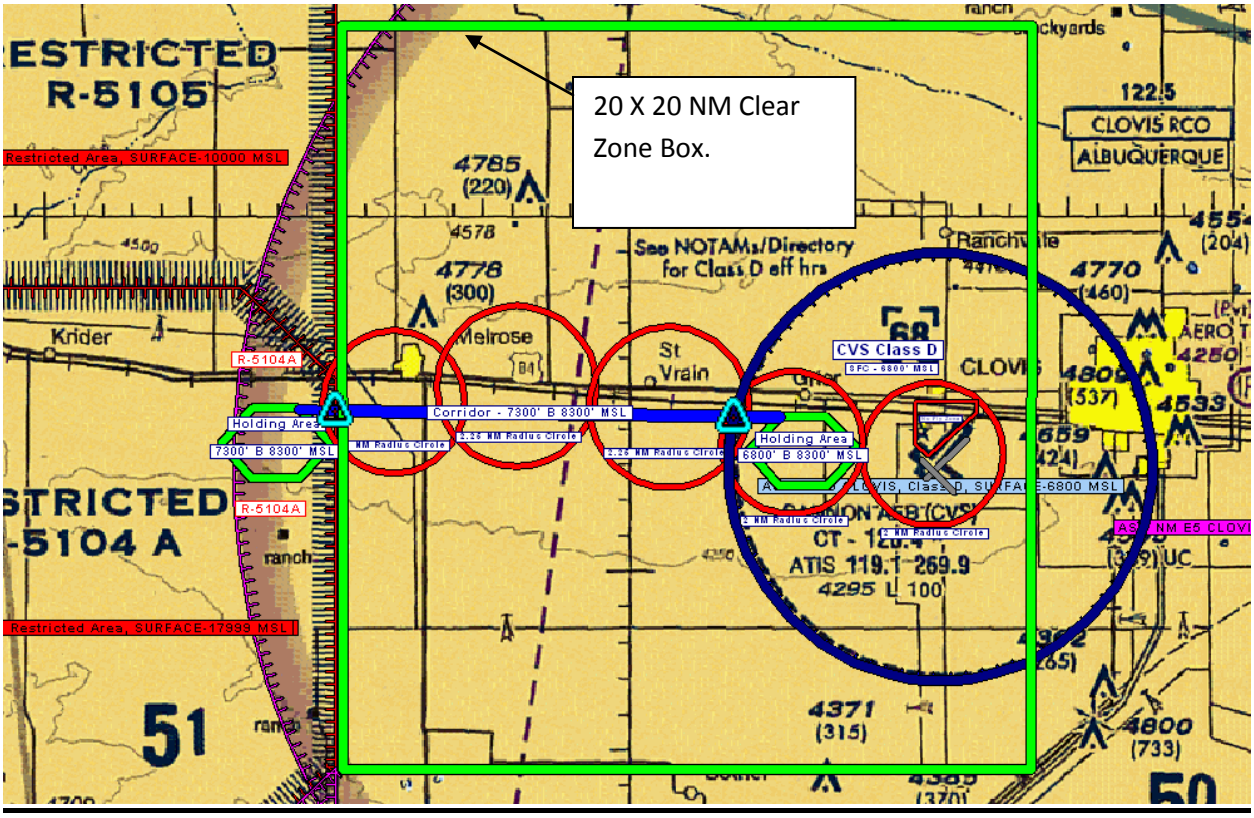

Figure 3. Proposed Clear Zone Box. Note: RAPCON would not release the MQ-1 from Class D holding orbit or R-5104 holding orbit unless they have communication with all aircraft within the clear zone box.

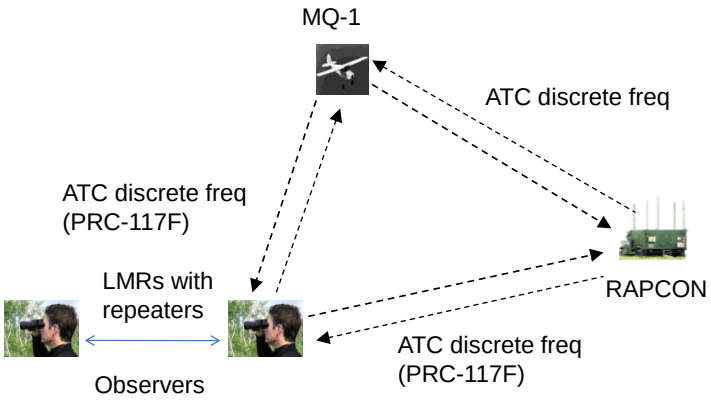

Figure 4. Proposed communications.