APPENDIX A.3. Test results, continued

3.1 – Debrief Form, OCAS evaluation- Helicopter

Date: **29 Aug 2005** Mast: **Milton** Pilot: Robert Poe (812 246 5454) / Rolf Bakken (OCAS) / Larry Buehler-Matthew Rigsby **(FAA)**

A/C reg: N-860DP A/C type: Jet Ranger, C20B
Takeoff: 15:13 Landing: 15:56 Tot time: :43

ID run #	Position at crossing	(Time local) +5 Z	Hdg Deg	Alt MSL (ft)	IAS (Mph)	Strobe	Audio signal			Ovh Obs (sec)	Audio Warn (sec)	Rmk #
						Start (N)	Start (sec)	Stop	Qual (1-5)			
1	90 Deg	15:18	Ne	**900**	110	X	+8.7	6x	5	+33.9	23.9	
2	"	:21	Sw	"	"	X	+9.9	6x	5	+33.1	22.6	
3	"	:24	Ne	**1000**	"	X	+10.5	6x	5	+33.4	21.9	
4	"	:27	Sw	"	"	X	+9.8	6x	5	+32.6	21.1	
5	"	:30	Ne	**1300**	"	-	-	-	-	-	-	
6	"	:33	Sw	"	"	-	-	-	-	-	-	
7	360	:36	020	**900**	"	X	+10.0	6x	5	+25.4	19.4	
8	265	:40	265	"	"	X	+12.6	6x	5	+30.2	22.8	
9	VHF Range Test	:42 to :53	West	1500	Verifying range of VHF radio transmission (Approximately 4-4.5 nm, GPS data to confirm range.							

REMARKS:

Warning Zone: 320m+15+15= 350 m (Radar +-30 m).

AWS set to **1150' msl**, (350 ft above North tower). The width of Warning Zone set to +- 25 m. A lower limit of 180 m (OCAS + 20 m **or** minimum 15 m/s (30 kts)

WZ height = 1150 ft (320+15m+15 m= 350 m). Top of twr North: 850 ft MSL (260 m). Top of twr South: 760 ft (232 m). Ground level, river: 420 ft. Spann length 3120 ft (950 m)

Warning: Always below 1050 ft. May between 1050 – 1350 ft. Not above 1350 ft.
Frequency: 123.025/121.700. Signal strength= **00 dB (-3dbm)**

GPS recorded data:
- "Mil FAA 29 1"= Run 1-9

RESULTS (Note#):
Run to be analyzed:

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All for final report. No deficiencies noted, excellent performance.

General:
Very good results.
Good flying conditions.
No False Warnings.
No warnings at or above 1300 ft.
OCAS stable/timely warnings.

Milton 29 Aug 05
Rolf Bakken

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APPENDIX A.3. Test results, continued

3.1 – Debrief Form, OCAS evaluation- Helicopter

Date: **29 Aug 2005** Mast: **Milton** Pilot: Robert Poe (812 246 5454) / Rolf Bakken (OCAS) / Vane Heal (Transport Canada)

A/C reg: N-860DP A/C type: Jet Ranger C30B
Takeoff: 17:56 Landing: 18:24 Tot time: :28

ID run #	Position at crossing	(Time local) +5 Z	Hdg Deg	Alt MSL (ft)	IAS (Mph)	Strobe	Audio signal			Ovh Obs (sec)	Audio Warn (sec)	Rmk #
						Start (N)	Start (sec)	Stop	Qual (1-5)			
1	90 Deg	18:01	Ne	**900**	110	X	+11.8	6x	5	+34.1	22.3	
2	"	:04	Sw	"	"	X	+4.3	6x	5	+28.1	23.8	
3	"	:07	Ne	**1000**	"	X	+12.5	6x	5	+36.1	23.6	
4	"	:10	Sw	"	"	X	+11.5	6x	5	+31.8	20.3	
5	North	:12	020	**900**	"	X	+10.0	6x	5	+35.0	25.0	
6	Descend, sim Final	:16	Sw	**1400-1000**	"	X	X	6x	5	+21.6	21.6	Warn at 1200 ft. 1)
7	Simulated lnd pattern	:19	North side-down wind-right base-final	**1500-1200-1000**	"	X	X	6x	5	+15.0	15.0	Warn at 1250 ft 2)

REMARKS:

Warning Zone: 320m+15+15= 350 m (Radar +-30 m).

AWS set to **1150' msl**, (350 ft above North tower). The width of Warning Zone set to +- 25 m. A lower limit of 180 m (OCAS + 20 m **or** minimum 15 m/s (30 kts)

WZ height = 1150 ft (320+15m+15 m= 350 m). Top of twr North: 850 ft MSL (260 m). Top of twr South: 760 ft (232 m). Ground level, river: 420 ft. Spann length 3120 ft (950 m)

Warning: Always below 1050 ft. May between 1050 – 1350 ft. Not above 1350 ft.
Frequency: 123.025/121.700. Signal strength= **00 dB (-3dbm)**

GPS recorded data:
- "Mil TC 29 1"= Run 1-7

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RESULTS (Note#):
Run to be analyzed:
All for final report. No deficiencies noted, excellent performance.

General:
Very good results.
Good flying conditions.
No False Warnings.
No warnings at or above 1300 ft.
OCAS stable/timely warnings.

1). Run started from NE, set up at 1400 ft (above WZ), then approximately 400 ft/min descend initiated at approximately 1500 meters (+30 sec) into the WZ to simulate a straight in approach. Immediate warning at approximately 1200 ft (+21.6 sec prior to crossing.

2). Run simulating a landing pattern. Starting on downwind at 1500 ft, turning base-final descending towards powerline. Immediate warning +15 seconds prior to crossing. (Simulating Floatplane landing on the river).

Milton 29 Aug 05
Rolf Bakken

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APPENDIX A.3. Test results, continued

3.1 – Debrief Form, OCAS evaluation- Helicopter

Date: **31 Aug 2005** Mast: **Milton** Pilot: Shenandoah, KU (+1 859 3210724) / Rolf Bakken (OCAS) / Karl-Andreas Flesland / Hugo Frivåg (Norwegian CAA)

A/C reg: N58428 A/C type: MD-500
Takeoff: 15:13 Landing: 15:56 Tot time: 43 min.

ID run #	Position at crossing	(Time local) +5 Zulu	Hdg Deg	Alt MSL (ft)	IAS (Kts)	Strobe	Audio signal			Ovh Obs (sec)	Audio Warn (sec)	Rmk #
						Start (N)	Start (sec)	Stop	Qual (1-5)			
1	Center	10:48	Ne	**900**	**110**	X	+13.5	6x	5	+34.0	20.5	1
2	"	:51	255	"	"	X	+11.3	6x	5	+31.3	20.0	
3	90	:56	Ne	**1000**	"	X	+12.3	6x	5	+33.3	21.0	
4	"	:59	Sw	"	"	X	+12.5	6x	5	+32.8	20.3	
5	"	11:03	Ne	**1350**	"	-	-	-	-	-	-	2
6	"	:08	Sw	**900**	**54**	X	+11.6	6x	5	+31.6	20.0	
7	010	:12	015	"	"	X	+10.7	6x	5	+36.4	25.7	
8	Center	:17	Ne	**700**	"	X	+14.6	6x	5	NA	NA	3
9	VHF Tx, same freq as audio warn	:20 to :23	N/W	1500	Test set up: 30 sec continuous audio warning, transmitting on same freq (123.025) between helicopter and OCAS gnd radio.							

REMARKS:

Warning Zone, upper: 320m+15+15= 350 m/ 1150 ft (Radar accuracy, elevation approximately +/- 30 m)

Warning Zone, Lower: OCAS Field Unit+20 meter (135 m field elev + 20m + 20 m / 575 ft MSL)

AWS set to **1150'** msl, (350 ft above North tower). The width of Warning Zone set to +- 25 m. A lower limit of 175 m (OCAS + 20 m **or** minimum 15 m/s (30 kts)

WZ height = 1150 ft (320+15m+15 m= 350 m). Top of twr North: 850 ft MSL (260 m). Top of twr South: 760 ft (232 m). Ground level, river: 420 ft. Spann length 3120 ft (950 m)

Warning:
Always below 1050 ft. May between 1050 – 1350 ft. Not above 1350 ft.
Frequency: 123.025/121.700. Signal strength= **00 dB (-3dbm)**

GPS recorded data:

- "Mil CAA 31 1"= Run 1-8

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- Run 8, operational run, "See and avoid", maneuver at +20 sec (30 deg bank, followed by climb above Tower South).

RESULTS (Note#):
Run to be analyzed:
Runs1-8. No deficiencies noted, excellent performance.
Run 9, repeat VHF test. Not coordinated satisfactory with OCAS ground.

Note:
1. Run flown following riverbank South side, several hdg changes, run-good.
2. Altitude control, small alt changes in range from +50-35 sec prior to crossing. Run-good.
3. Simulating "normal ops", starting left climbing turn, 30 deg bank, at audio warning. Pilot comment, timely and well clear of obstacle at heading away (approx 500 m +)

General:
Very good results.
Good flying conditions.
No False Warnings.
No warnings at or above 1350 ft.
OCAS stable/timely warnings.

Milton 31 Aug 05
Rolf Bakken

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APPENDIX A.3. Test results, continued

3.1 – Debrief Form, OCAS evaluation- Helicopter

Date: **31 Aug 2005** Mast: **Milton** Pilot: Shenandoah, KU (+1 859 3210724) / Rolf Bakken (OCAS) / Jan Roar Pleym (OCAS) / Tom Roar Pedersen (OCAS)

A/C reg: N58428 A/C type: MD-500
Takeoff: 12:00 Landing: 12:17 Tot time: 17 min.

ID run #	Position at crossing	(Time local) +5 Zulu	Hdg Deg	Alt MSL (ft)	IAS (Kts)	Strobe	Audio signal			Ovh Obs (sec)	Audio Warn (sec)	Rmk #
						Start (N)	Start (sec)	Stop	Qual (1-5)			
1	VHF Test	12:01-:03	Sw	**1000**	**50**	Audio Continous, gnd strength 3/Heli 5			3/5			1
2	Center	:06	Ne	**900**	100	X	+12.2	6x	5	+34.1	21.9	
3	90	:09	Sw	"	"	X	+12.3	6x	5	+34.1	22.7	
4	"	:13	Ne	**700**	"	X	+9.8	6x	5	NA	NA	2
1)	VHF Tx, same freq as audio warn	:01 to :03	Test set up: 30 sec continuous audio warning, transmitting on same freq (123.025) between helicopter and OCAS gnd radio.									

REMARKS:

Warning Zone, upper: 320m+15+15= 350 m/ 1150 ft (Radar accuracy, elevation approximately +/- 30 m)

Warning Zone, Lower: OCAS Field Unit+20 meter (135 m field elev + 20m + 20 m / 575 ft MSL)

AWS set to **1150' msl**, (350 ft above North tower). The width of Warning Zone set to +- 25 m. A lower limit of 175 m (OCAS + 20 m **or** minimum 15 m/s (30 kts)

WZ height = 1150 ft (320+15m+15 m= 350 m). Top of twr North: 850 ft MSL (260 m). Top of twr South: 760 ft (232 m). Ground level, river: 420 ft. Spann length 3120 ft (950 m)

Warning:
Always below 1050 ft. May between 1050 – 1350 ft. Not above 1350 ft.
Frequency: 123.025/121.700. Signal strength= **00 dB (-3dbm)**

GPS recorded data:
- "Mil FAA 31 1"= Run 1-4
- Run 4, operational run, "See and avoid", maneuver at +20 sec (30 deg bank, follow by climb above Tower South).

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RESULTS (Note#):
Run to be analyzed:
Runs1-4. No deficiencies noted, excellent performance.
Run 1, VHF test. Good results, observed by Vane Heal / Transport Canada (on gnd).

General:
Very good results.
Good flying conditions.
No False Warnings.
No warnings at or above 1350 ft.
OCAS stable/timely warnings.

Milton 31 Aug 05
Rolf Bakken

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APPENDIX A.4. Radar plots

Figures and views are explained in appendix A2. Overview of flight runs is given in A3. Magenta line is GPS log from onboard GPS. Blue line is actual OCAS radar log.

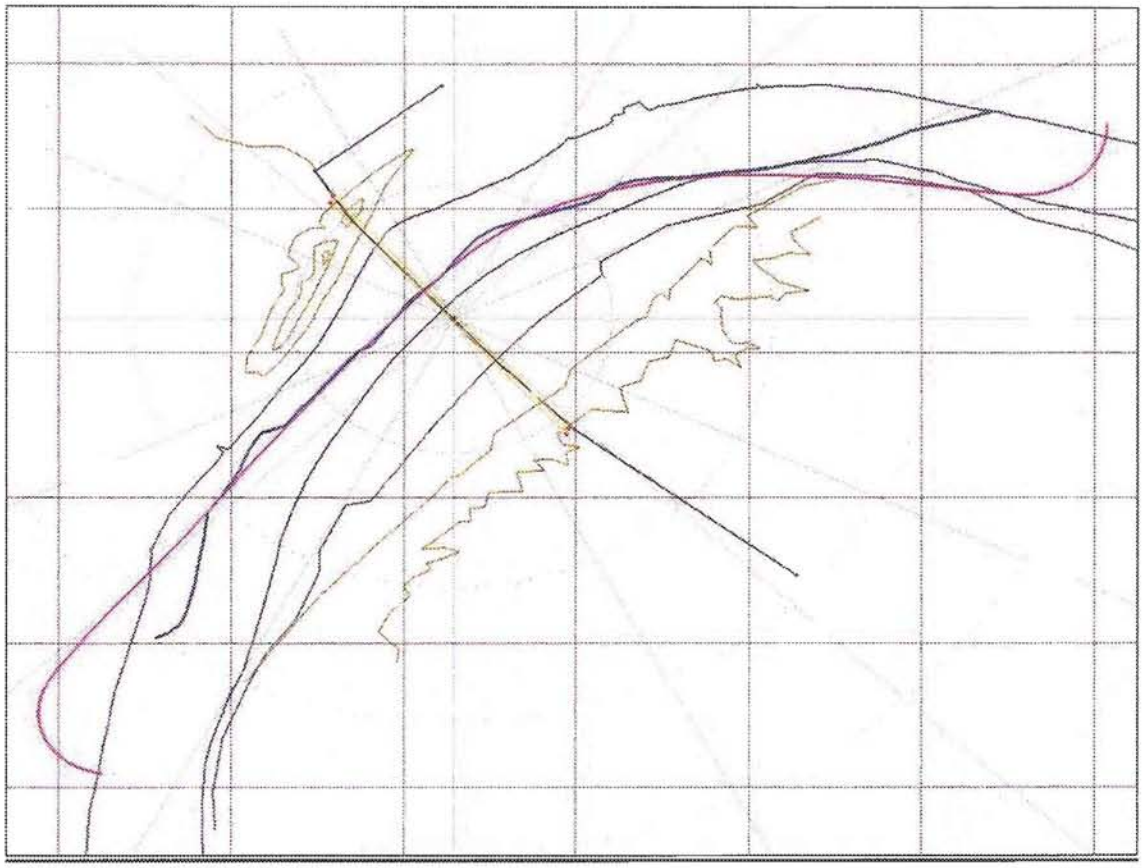

Figure 1: 20050829_1 GA run 8, top view

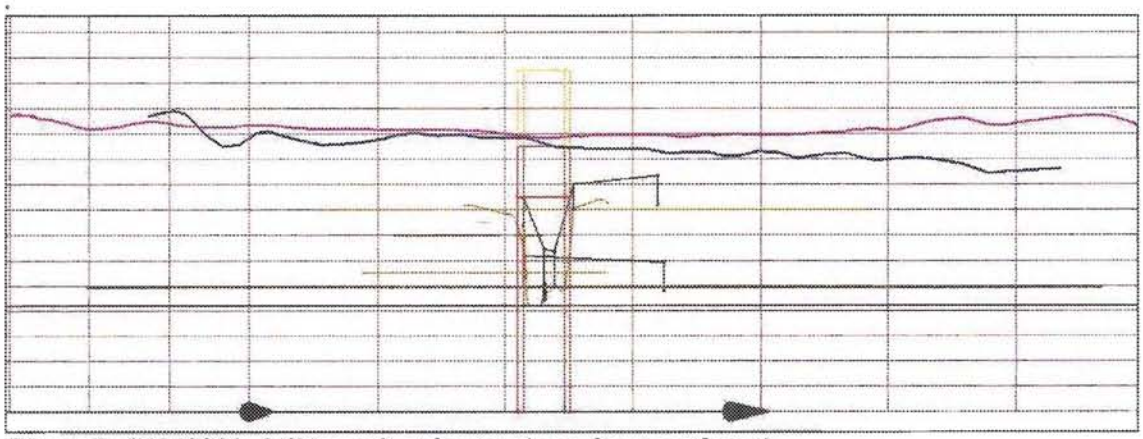

Figure 2: 20050829_1 GA run 8, side view (seen from southeast)

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APPENDIX A.4. Radar plots, continued

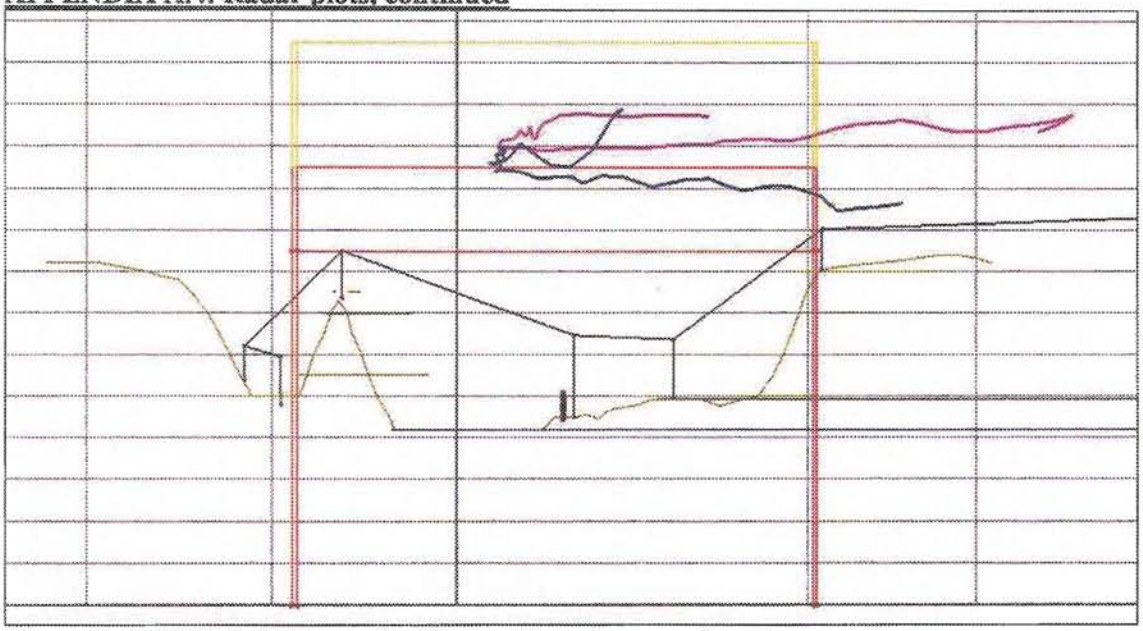

Figure 3: 20050829_1 GA run 8, side view (seen from southwest)

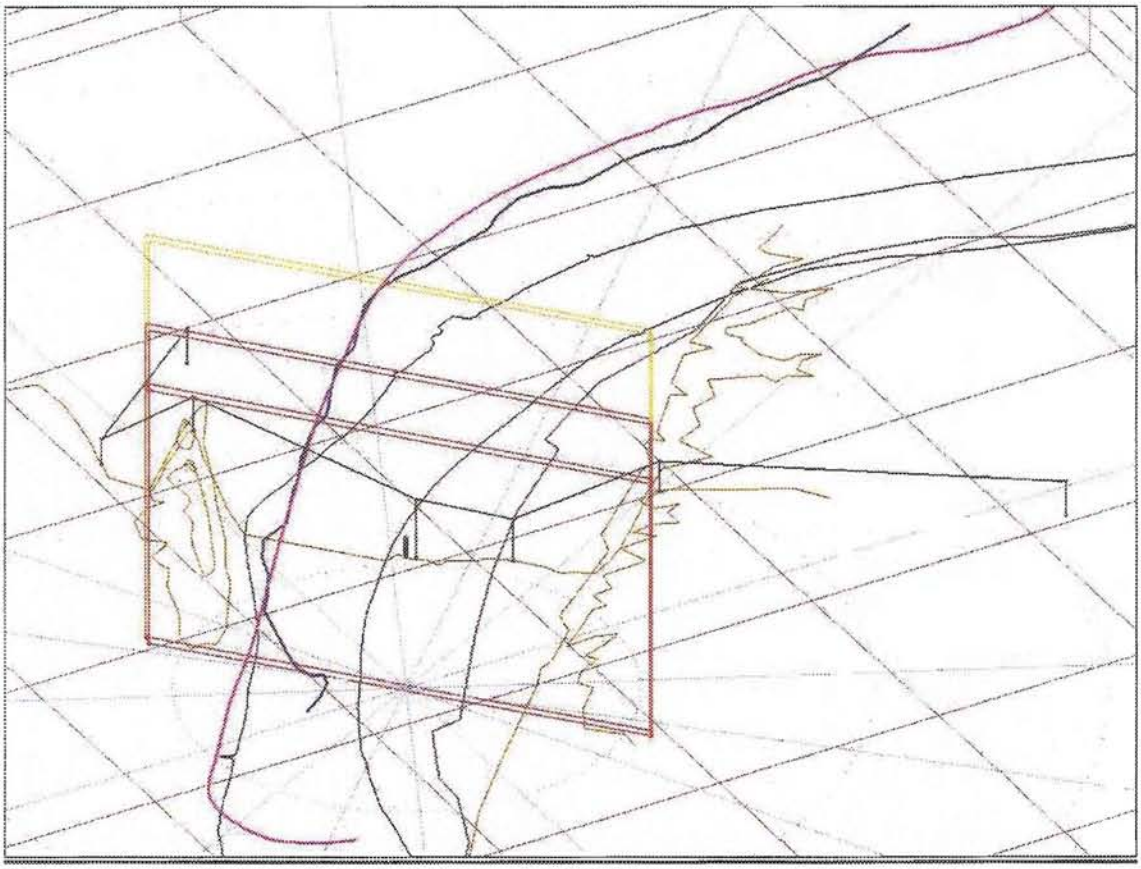

Figure 4: 20050829_1 GA run 8, 3D view

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APPENDIX A.4. Radar plots, continued

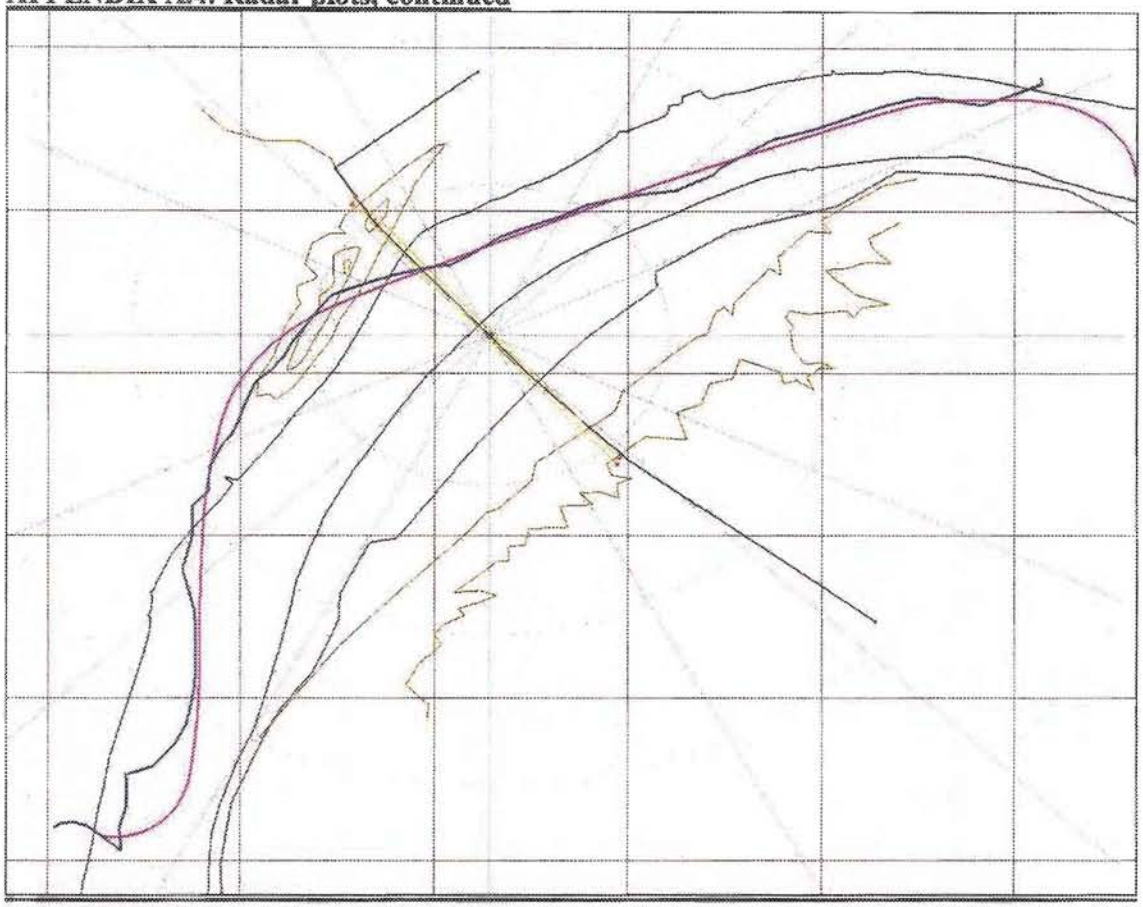

Figure 5: 20050829_1 GA run 23, top view

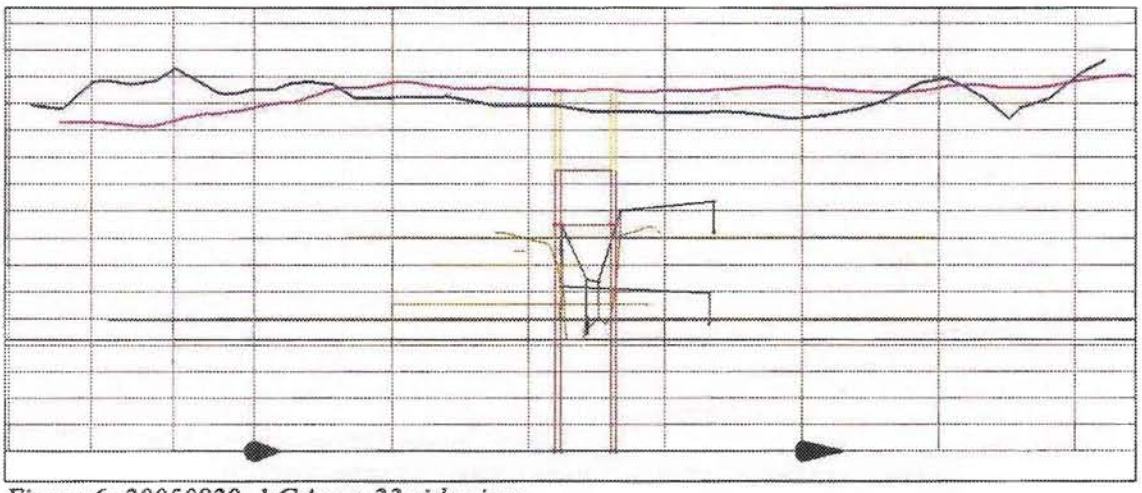

Figure 6: 20050829_1 GA run 23,side view

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APPENDIX A.4. Radar plots, continued

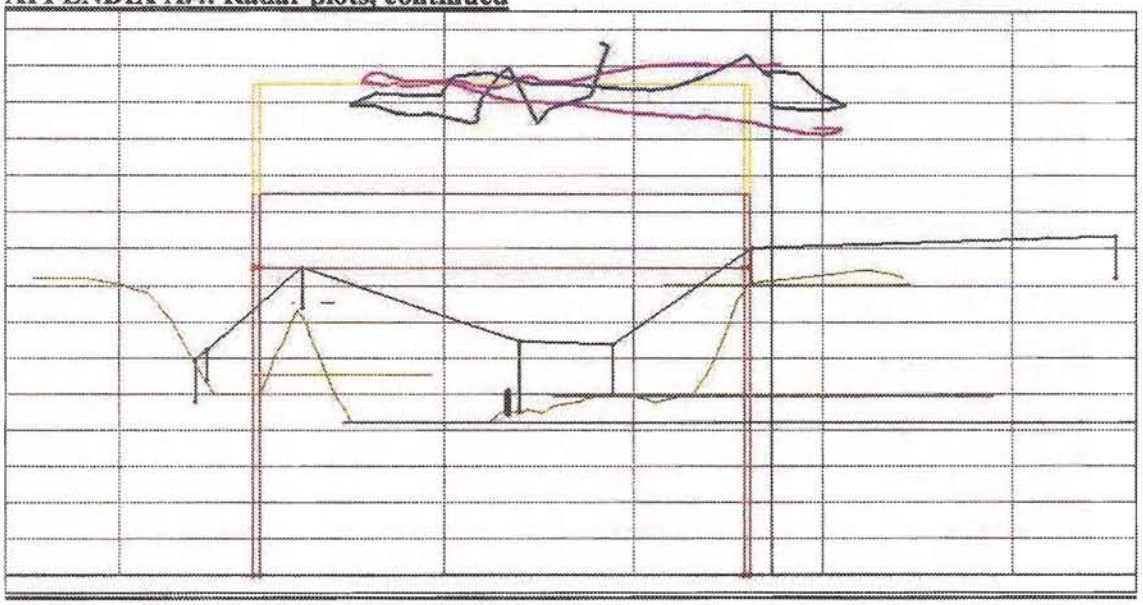

Figure 7: 20050829_1 GA run 23,side view

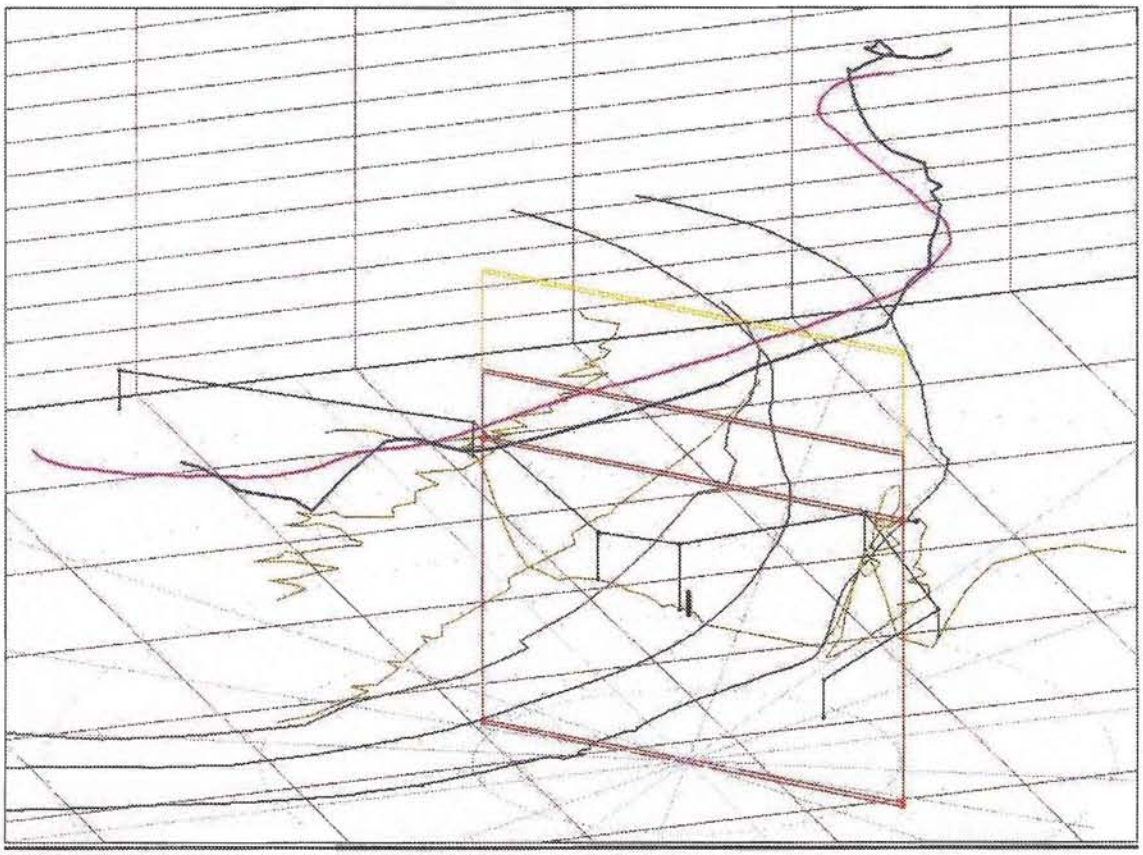

Figure 8: 20050829_1 GA run 23, 3D view

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APPENDIX A.4. Radar plots

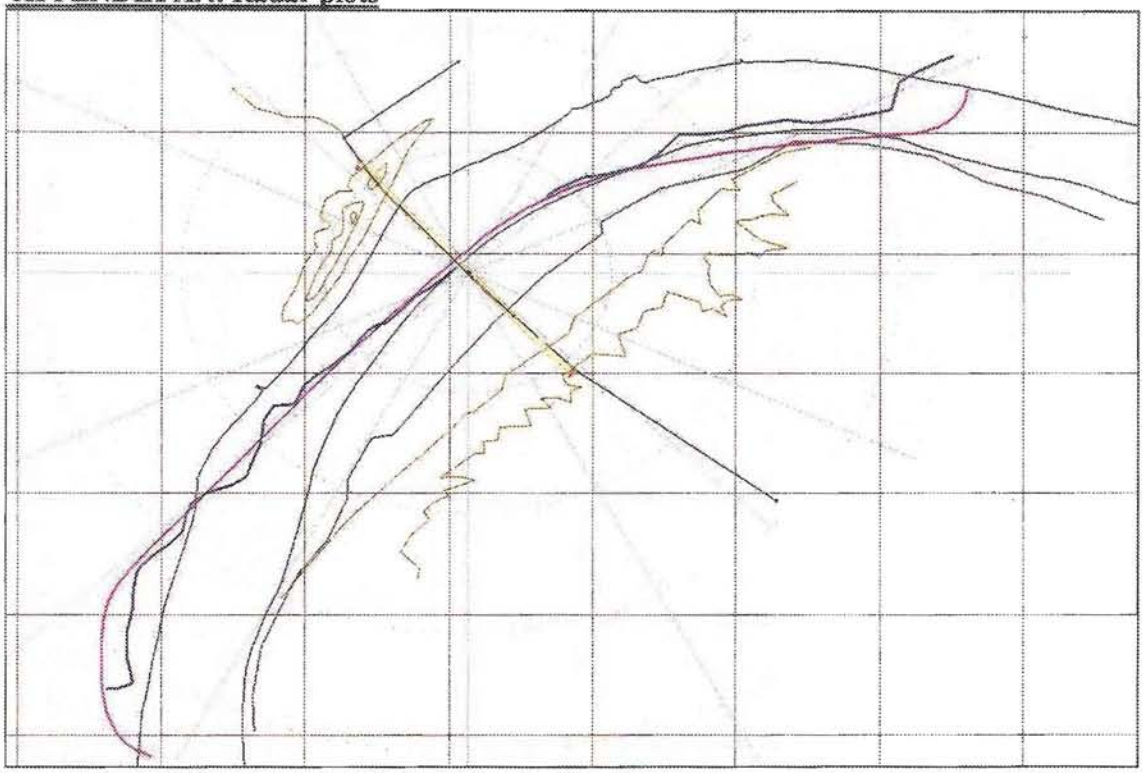

Figure 9: 20050829_3 FAA HELI run 3,top view

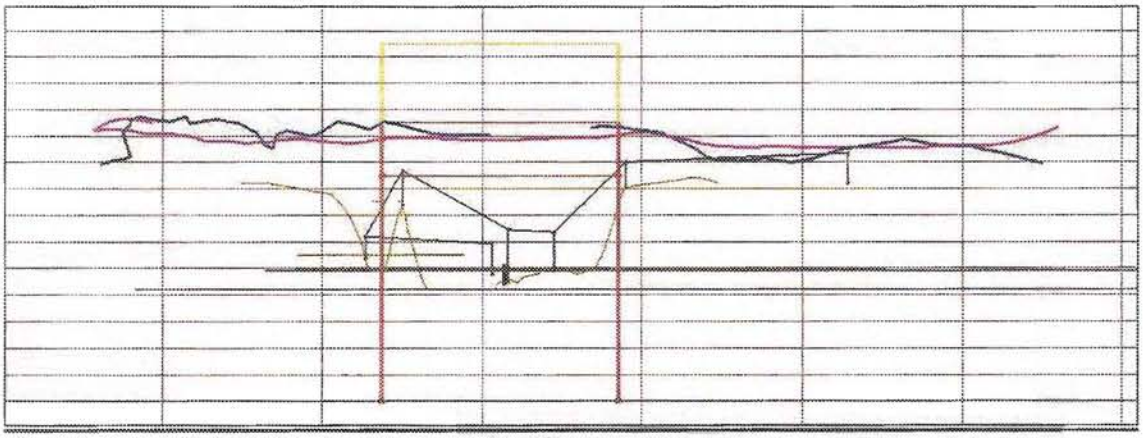

Figure 10: 20050829_3 FAA HELI run 3, side view

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APPENDIX A.4. Radar plots, continued

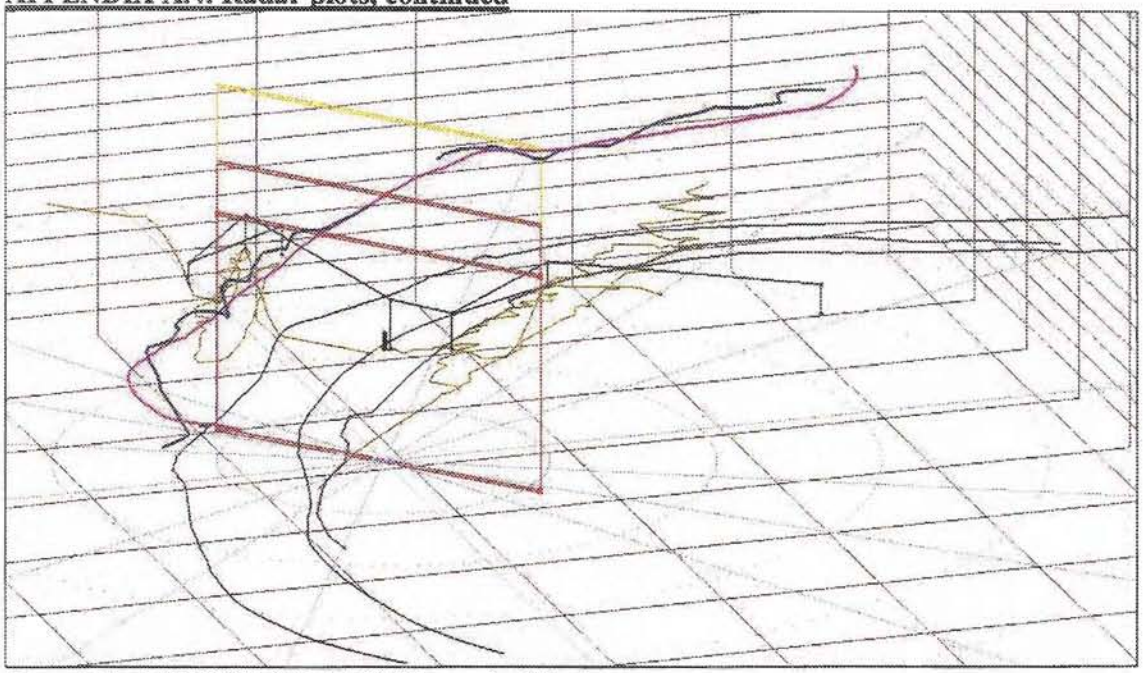

Figure 11: 20050829_3 FAA HELI run 3, 3D view

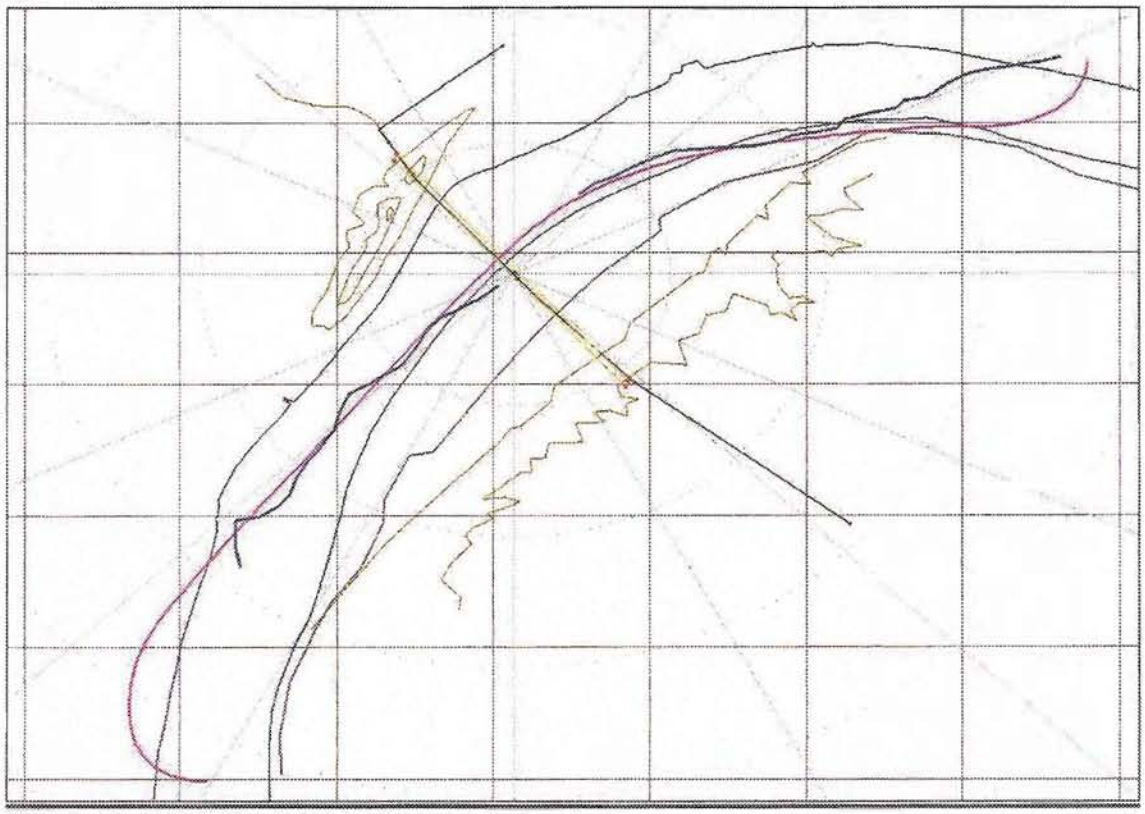

Figure 12: 20050829_3 FAA HELI run 5, top view

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APPENDIX A.4. Radar plots, continued

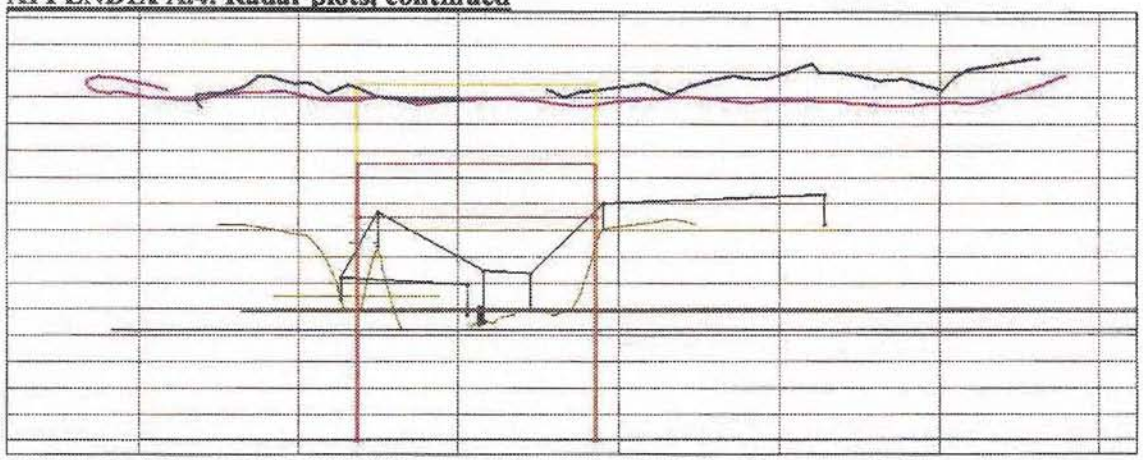

Figure 13: 20050829_3 FAA HELI run 5, side view. OCAS radar cone of silence may cause track interruptions when very close to the radar. This should have no negative operational impact on the warning system, warnings will be issued well ahead of such interruptions.

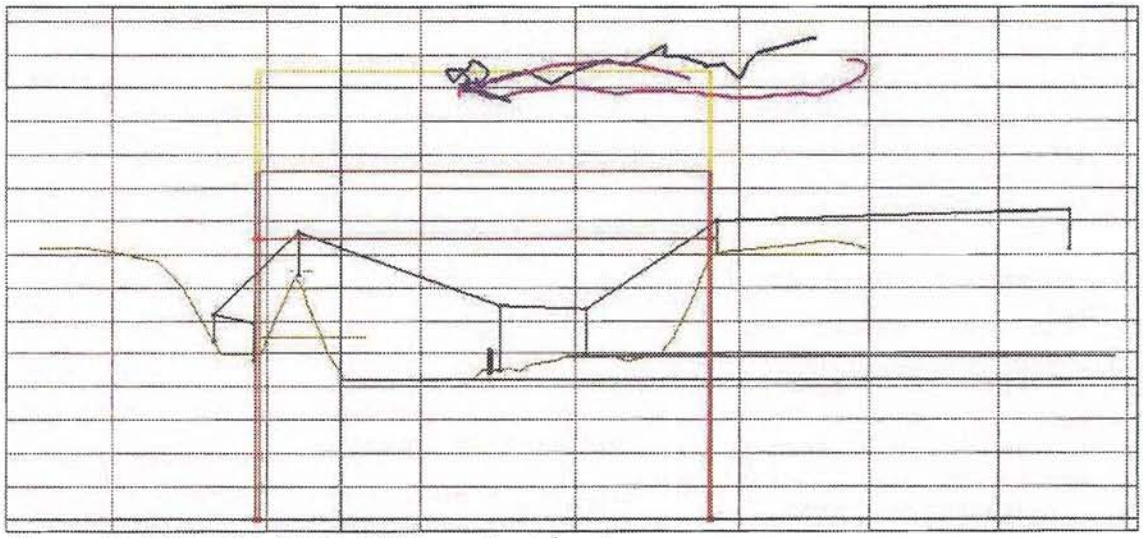

Figure 14: 20050829_3 FAA HELI run 5, side view

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APPENDIX A.4. Radar plots, continued

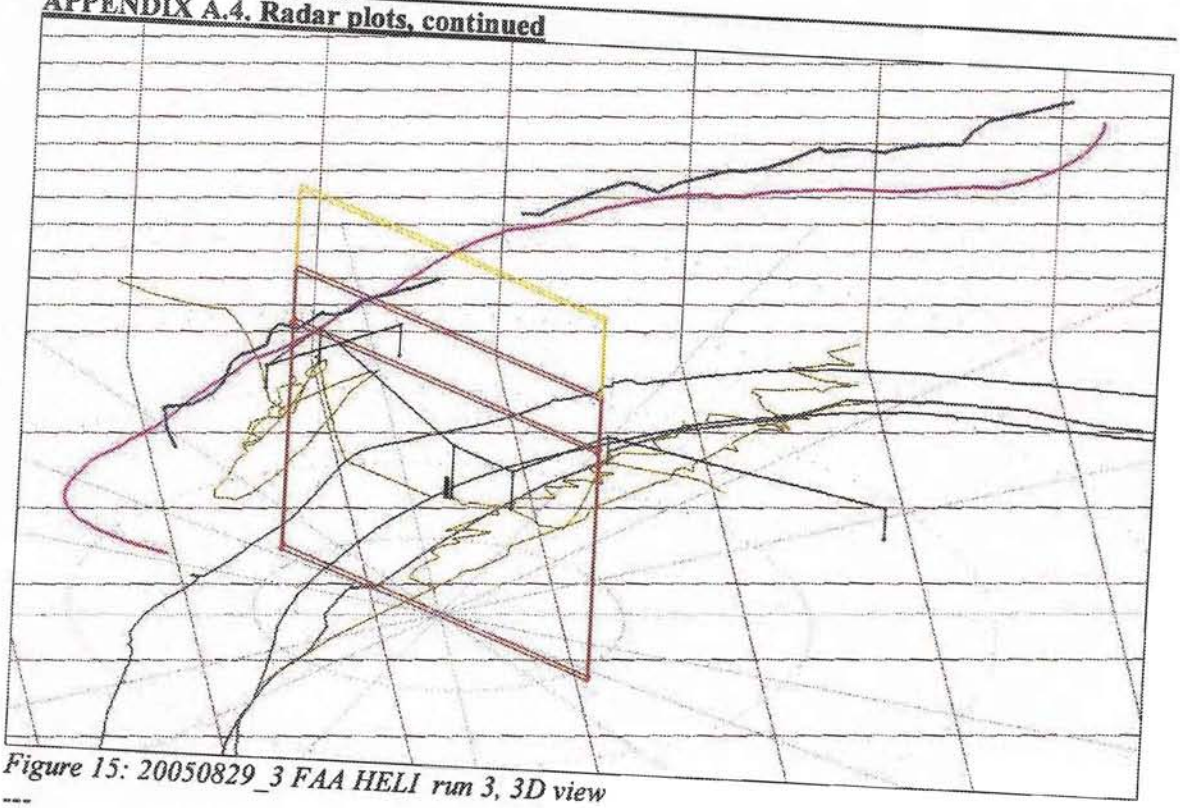

Figure 15: 20050829_3 FAA HELI run 3, 3D view

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APPENDIX A.5. Radar plots, radar measurement accuracy

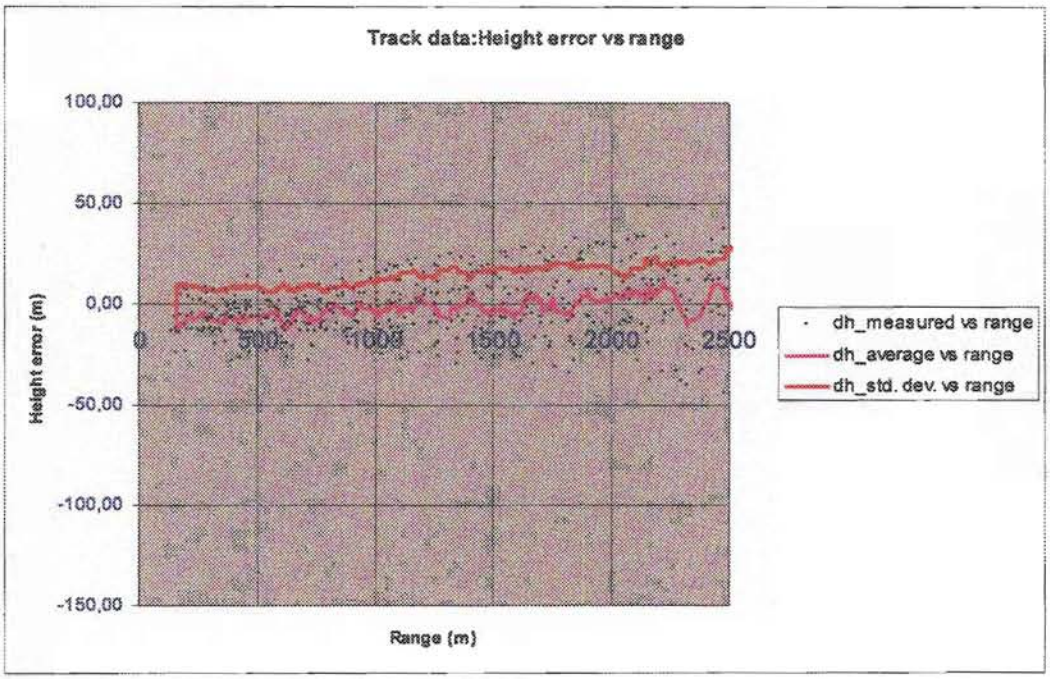

Figure 1 Measured height error (relative GPS) for 6 flights in Milton in the period August 29-31 2005.

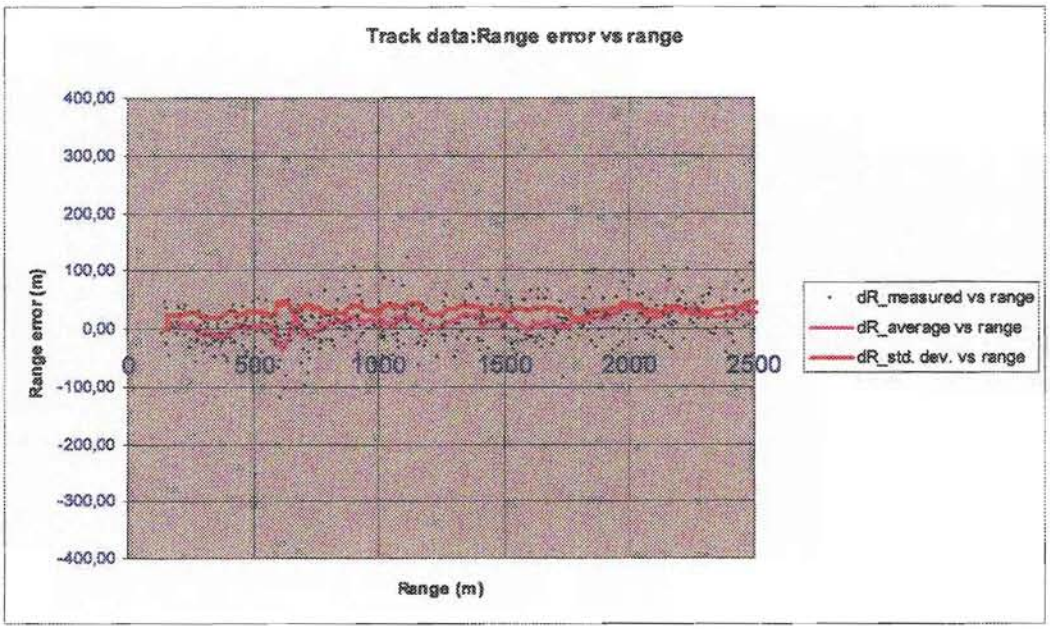

Figure 2 Measured range error (relative GPS) for 6 flights in Milton in the period August 29-31 2005.

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APPENDIX A.5. Radar plots, radar measurement accuracy, continued

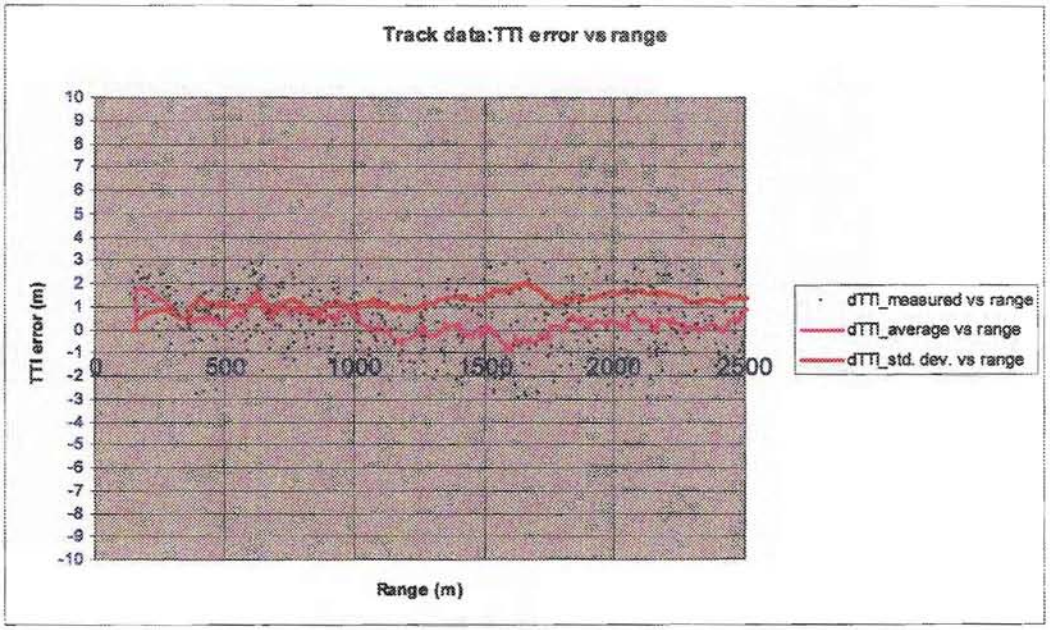

Figure 3 Measured time-to-impact error (relative GPS) for 6 flights in Milton in the period August 29-31 2005.

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APPENDIX A.5. Transport Canada test report.

Quote:

Operational Collision Avoidance System (OCAS)

Transport Canada Test report at Milton KY

August 29 till 31 2005

Operational evaluations were conducted at Milton Kentucky over a three-day period. The Kentucky Utilities working with the OCAS manufacturer to demonstrate a cost effective operational system to increase safety and replace current marking practices sponsored the evaluations. During previous evaluations the OCAS manufacturer had received valued input and specification from the regulators of Norway, USA and Canada, which over the last year have been successfully integrated into the system.

During the previous two weeks the system had been upgraded with both hardware and software developed over the previous year. The Kentucky Utilities provided a Hughes 500 helicopter and OCAS rented a Cessna 150 to calibrate and verify system performance specifications. On August 29, 2005 during the first day of evaluation, OCAS rented a Bell 206 helicopter for the regulators to view the system. During my flight I asked the pilot for his opinion on the overall system performance. The pilot with some 40 years experience stated it was a fantastic system that would save lives.

The OCAS system performed flawlessly during the evaluation period. It meets all specifications.

The regulators had closed meeting for one day discussing the system and concerns that they may have had. It was interesting to find out that there were common issues to all. The main issues were depicting the system on charts, frequency assignment, system monitoring and if there are further redundancy requirements. The regulators have agreed to share all supporting documentations to expedite the process for acceptance as an alternate method to mark and light obstacles. The OCAS management is performing a risk assessment to demonstrate an equivalent level of safety or better compared to current standards.

The Norwegian CAA has issued technical approval to the manufacturer for operational use in Norway.

The FAA inspectors determined that the Operational Evaluation was successful and is proceeding with an exemption to their current standards. In order to do so, they will be conducting a risk assessment with all supporting documentation supporting an equivalent level of safety or better. As discussed with the Manager of Aerodrome Safety and Air Navigation, Mr. Chris Cox, Inspector Geoff Graham and I will be providing the documentation requesting an exemption to the current standards

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obstruction markings (TP382) with supporting data for accepting OCAS. OCAS has now demonstrated it provides the equivalent of safety or better to the present standard.

Wayne V. Heal
Civil Aviation Safety Inspector
Aerodromes and Air Navigation
Transport Canada, Pacific Region
Phone 604-666-1090
Fax 604-666-8877

End Quote

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EXHIBIT 3

Federal Aviation Administration

Memorandum

Date: JUL 31 2007

To: Manager, Flight Standards Division, Southern Region, ASW-112
Manager, Aeronautical Information Management Group, AJR-33
Manager, Office of Spectrum Policy and Management, ASR-100
Manager, Airport Safety and Operations Division, AAS-100

From: Thomas K. Toth, Manager, Air Transportation Division, AFS-200

Prepared by: Larry Buehler, Commuter, On Demand and Training Center, AFS-250

Subject: Obstacle Collision Avoidance System

The Federal Aviation Administration Flight Standards Service's review and analysis indicates that the Obstacle Collision Avoidance System (OCAS) reflected in the attached documents provides an equivalent level of safety and a suitable alternative to the lighting and marking requirements of obstacles as recommended in Advisory Circular 70/7460-1.

The attached technical data, testing, and summary data is provided for your consideration. The demonstration observed by representatives of the FAA is enclosed at Tab 10.

Flight Standards Service requests your concurrence by August 17, 2007, so that the OCAS system may be used in lieu of local area lighting and marking of obstacles.

Tab 1 - Concept of Operation
Tab 2 - OCAS B+ System Description
Tab 3 - OCAS B+ General Requirements
Tab 4 - OCAS B+ System Requirement
Tab 5 - Test Report No. 67721-2
Tab 6 - Test Report No. 67721-5
Tab 7 - Test Report No. 67721-9
Tab 8 – Functionality and Risk Assessment of Collision, Avoidance Systems on manmade obstacles
Tab 9 - Notified Body Opinion
Tab 10 - Flight Test Report, Milton Kentucky
Tab 11 - OCAS B+ Site Installation Checklist
Tab 12 - OCAS B+ Installation Verification & Flight Test Specification

EXHIBIT 4

Federal Aviation Administration

Memorandum

Date: JUN 15 2009

To: Obstruction Evaluation Services Personnel

From: Kevin Haggerty
Manager, Obstruction Evaluation Services

Subject: Changes to Federal Aviation Administration (FAA) Advisory Circular (AC) 70/7460-1K, Obstruction Marking and Lighting

We are preparing changes to FAA AC 70/7460-1K, Obstruction Marking and Lighting. The changes will incorporate Audio Visual Warning Systems (AVWS) as an acceptable form of marking and lighting that will meet established technical standards to identify an obstruction to air navigation.

AVWS is an all-weather, day and night, low-voltage, Radar-based obstacle avoidance system that utilizes current obstruction lighting products and does not require additional equipment in an aircraft.

AVWS activates obstruction lighting and audio signals to alert pilots of potential collisions with obstacles such as power lines, wind turbines, bridges, and towers. The obstruction lights and audio warnings are inactive when there is no air traffic in the area of the obstruction.

The FAA has analyzed and reviewed the Obstruction Collision Avoidance System (OCAS™) and has determined that OCAS™ provides an equivalent level of safety and is a suitable alternative to the marking and lighting requirements of obstacles as recommended in FAA AC 70/7460-1K.

OCAS™ is the first AVWS to be installed, tested, and approved in the National Airspace System (NAS).

The OES will accept, analyze, and approve an AVWS as an alternative to conventional lighting systems on a case-by-case basis.

OES personnel shall:

1. Review each FAA Form 7460-1, Notice of Proposed Construction or Alteration, for requests to use an AVWS.

2. If an AVWS is indicated, select "AVWS" as the requested Marking and Lighting.
3. Ensure that Technical Operations and Spectrum Engineering are selected to provide comment on the aeronautical study.
4. Business rules will be incorporated into the Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) System based on AVWS as the Requested Marking/Lighting to override current auto screens and ensure proper coordination. If AVWS is not selected as the Requested Marking/Lighting, ensure that the case is manually unlocked for review from AF and FM.
5. Before the issuance of the Determination, ensure that comments from Technical Operations and Spectrum Engineering are reviewed and specifically acknowledge that the AVWS was reviewed, approved, or conditionally approved (e.g., No Audio).
6. Adjudicate all AVWS concerns and indicate in the Additional Information section that AVWS is approved for the specific study with or without conditions or limitations prior to the issuance of a Determination of No Hazard to Air Navigation.
7. If AVWS is approved with conditions or limitations or if AVWS is not approved: provide your supervisor with the Aeronautical Study Number and wait for approval to issue the Determination of No Hazard to Air Navigation.
8. Ensure that the 7460-2, Notice of Actual Construction or Alteration, indicates that AVWS is installed.

The OES will incorporate an AVWS section to the external OE/AAA Web site to inform the public about AVWS and its benefits in the NAS.

Please direct any questions or comments to the Manager, OES.