NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

July 26, 2010

CHIEF SCIENTIST'S REPORT

H44 APPROACH AND LANDING STUDY

LAX08PA259

A. ACCIDENT

Operator:	United States Forest Service
Location:	Weaverville, CA
Date:	August 5, 2008
Time:	1941 Pacific Daylight Time (pdt)
Airplane:	Sikorsky S-61N N612AZ

B. CHIEF SCIENTIST

John Clark

C. SUMMARY

The copilot stated during post-accident interviews that the outside air temperature prior to the accident takeoff was 22° C. About one minute before landing at Helispot 44 (H44), the cockpit voice recorder (CVR) recorded the copilot stating that the outside air temperature (OAT) was 20° C. Subsequent evaluation of all available meteorological information leads the Safety Board's Senior Meteorologist to conclude that the temperature was 23°C+/-1 at the time of the ill fated takeoff from H44.

Carson Helicopter believes that the 20° C as recorded on the CVR is the most likely temperature at H44 at the time of the attempted takeoff. They base their conclusion in part on the copilot's statement "we're at six thousand feet now" that was recorded on the CVR at 19:33:31 (about 2minutes before the final landing at H44). The assumption is that the helicopter would not have climbed between the time of the 6,000 feet call and landing at H44. During the interval, the 20° C calls

were made, thus it could be argued that the calls were made while the helicopter was near an altitude of 6,000 feet and the temperature was near 20°C

This study has led to the conclusion that 22° C as remembered by the copilot and the 23° +/-1° C as determined by the Senior Meteorologist are likely the correct temperature range at the time of takeoff from H44. Equally important, the reference on the CVR to 20° C is also correct because the helicopter was likely at about 6600 feet or higher at the time of the call rather than 6000 feet as reasoned by Carson.

D. STUDY

The Sky Connect data[1], Cockpit Voice Recorder data, and witness statements were used. Position data and selected CVR comments are presented in Google Earth images. Sky Connect data contained GPS – derived time, position, altitude, ground speed, and direction of flight for N612AZ (Attachment 1). The Cockpit Voice Recorder Group Chairman's Factual Report contained comments and respective timing. The CVR group chairman provided spectrum graphs of engine sound signatures that indicated increasing or decreasing engine power (N_G, i.e., engine gas-generator speeds), shown in Attachment 2. A summary of events, timing, distances and speeds are provided in Attachment 3. Various scenes using Google Earth are presented in Attachment 4.

The USFS on-scene commander stated that he could hear N612AZ approaching from the east and he observed the helicopter crossing the ridge North-East of him [the ridge extended 055 degrees from his location][2]. The helicopter was on a north-westerly track, approximately ½ to ¾ of a mile away (estimated 40:55:13 N, 123:14:33 W, elevation 6,040 feet). He remembers that the helicopter appeared high above the ridge; he estimated 800 to 1,000 feet above the terrain. The ridge is about 6100 to 6200 feet high at ¾ mile from H44. If the helicopter crossed the ridge with a 400 feet margin, the crossing elevation would have been about 6600 feet. Eight hundred feet above the ridge, as estimated by the on-scene commander would yield a crossing altitude of about 6900 to 7000 feet. In any case, it is clear that in order to cross the ridge as observed by the commander, the helicopter must have climbed well above the 6000 ft. altitude called out by the copilot at 19:33:31.

At 19:31:20, the SkyConnect data indicates that the helicopter was about 5.5 nm east-southeast of H44 at an altitude of 4423 ft. Shortly after, at 19:31:39,

[1] Sky Connect is a GPS-based unit that transmits position, altitude, and groundspeed information to a remote receiver. Tracks are true; speeds are in knots ground speed; and altitudes are true.

[2] See "Additional Information from Witness" in the public docket for this accident.

the captain asks “why am I down to four thousand,” and at 19:31:42, the copilot stated “we’re going for that saddle right there.” Figure A4.2 (in Attachment 4) shows the position of the helicopter at these points (based on an interpolation of the SkyConnect data) in a Google Earth image. The “saddle” that is likely referred to by the crew is also shown. The lowest elevation in this saddle, per Google Earth, is about 6070 ft. A direct line between the SkyConnect points on either side of the saddle would bear about 290°. Sky Connect data show that at 19:33:26, the helicopter was about 0.8 nm northwest of the saddle at 6302 feet and tracking 320° at 122 knots[3]. This position is consistent with the helicopter just having passed through the saddle on a track of about 290°, and then having made a right turn to 322°, as opposed to flying through the saddle and proceeding straight to H44. Tracking 322° from this position to the ridge, the ridge elevation would be about 6100 feet. However, a further turn to the right would result in the helicopter crossing the ridge over higher elevations. The 322° track is relatively perpendicular to the ridge.

Comments on the CVR are consistent with the helicopter continuing to track further right to avoid smoke after crossing saddle:

19:33:31.4 [INT-2 copilot] yup we’re at six thousand feet now (ground track 322 degrees)
19:33:34.0 [INT-1 pilot] we’re just gunna come to the right so we can get better visibility
19:33:43.0 [INT-1] …come here a little bit more to the right here for the visibility sake
19:33:47.6 [INT-1] we’ll just cut right to the edge of the smoke here until I can pick up the ridge

Another comment confirms the helicopter position:

19:34:10.0 [INT-2] should be right out at our ten o’clock (see Figures A4.4 and A4.5)

An earlier comment again suggests that the pilots intended to fly across the ridge and turn back to H44:

19:33:52 [INT-2] you can fly past it and come back around

A possible flight path for the helicopter between the SkyConnect points at 19:33:26 (just west of the saddle) and 19:35:32 (near H44) that is consistent with the SkyConnect data, the observations of the USFS commander, engine power

[3] All CVR times are referenced to Pacific Daylight Time. Times on the spectrum graphs are elapsed time in seconds, where 985 seconds = 19:36:03 H:M:S local time. Altitude references heard on the CVR are indicated altitude.

information and crew comments recorded on the CVR, and reasonable assumptions about the speed of the helicopter during the approach to H44 is shown in the figures in Attachment 4. This flight path was constructed by first estimating the speed of the helicopter between the reported SkyConnect points, and then integrating this speed to obtain a total distance travelled between the SkyConnect points. A path of this length that has the general shape of a left downwind-base-final pattern was then fit between the SkyConnect points, as shown in the figures of Attachment 4.

Figures 3.2 and 3.3 show the assumed speed as a function of time used to construct the flight path. Note that this Figure shows:

- The SkyConnect speeds at 19:33:26 and 19:36:04
- A deceleration from 120 kts to 70 kts between19:33:26 and 19:34:10. During this time, speed is traded for altitude as the helicopter climbs to clear the ridge. The CVR sound spectrum shows a slight drop in engine power during this transition (see Figure A2.3 in Attachment 2). A speed of 70 kts for the "downwind" leg of the approach to H44 is assumed until the CVR records the captain stating "down wind left down wind slowin' down" at 19:34:40. At this point, a gradual deceleration throughout the remainder of the flight, to zero speed over H44, is assumed.

The reconstructed flight path is consistent with the copilot's statement at 19:34:10 that H44 "should be right out at our ten o'clock," and places the helicopter over the ridge at about 19:34:30 (see Figure A4.1).

Flying the path as depicted in Figures A4.1 and A4.6 in Attachment 4 would require an average speed of about 82 knots[4] from the last Sky Connect data point to the ridge, and an average speed of about 50 knots to descend and circle to the left to reach the flare for H44. The helicopter would travel about 1.5 nm from the 19:33:26 Sky Connect data to reach the ridge. Based on the on-scene commander's statement, the helicopter climbed as it flew from the most recent Sky Connect position toward and above the ridge. At 19:34:40, the CVR sound spectrum graphs shows that the engine power decreased dramatically (see Figure A2.4), suggesting that the ridge had been crossed and that the helicopter was at or near the apex of the flight path or starting the descent. The reconstructed flight path indicates that the helicopter had flown about 1/4 nm after crossing the ridge when the power was reduced. The helicopter had flown

[4] The average speed was derived by using 120 knots at the "6,000" feet call and 60 knots at the power reduction at 19:34:40, shown in Attachment 2 as Figure A2.3 (this power reduction is discussed further below) . A constant deceleration between these points would result in an average speed of 90 knots. However, a greater deceleration is assumed at the start of the segment and a lesser deceleration is assumed at the end of the segment.

about 0.3 nm after crossing the ridge when the copilot advised that the OAT was 20° C (at 19:34:43.0).

Although precise altitude/position/speed determinations are not possible with the available data, it is clear that the helicopter was in the vicinity and above the ridge when the 20° C call was made. The copilot recalled that the temperature at H44 was 22° C. The H44 elevation is about 6,000 feet. The temperature at 6,600 feet would be about 20° C with a dry adiabatic lapse rate of 3° C/1000 feet (the standard adiabatic lapse rate is about 2° C/1000 feet)[5]. Therefore, the 20° C callout on the CVR and the 22° C temperature at H44 as remembered by the copilot appear to be accurate and consistent with the Safety Board's Senior Meteorologist factual report.

Note: A flight path directly from the saddle to H44 is not consistent with the available data and power settings as depicted in the sound spectrum graphs, or with the testimony of the USFS commander. The Sky Connect data at 19:33:26 show the helicopter had made a right turn and was tracking 322 degrees. Further, the helicopter would have slowed to an average speed of only 44 knots in order to cover the direct distance to H44 (about 1.5 nm) in 2min 6sec.

E. FINDINGS

1. The helicopter crossed the ridge at a point where the ridge was about 6300 feet.
2. An altitude margin of 300 feet above the ridge (or 200 feet above the trees) would place the helicopter at 6600 feet (at a minimum).
3. The temperature at the time of crossing was likely about 20° C as heard on the CVR.
4. The elevation of H44 is about 6000 feet or about 2° C warmer than at the crossing altitude of 6600 feet.
5. A temperature of 22° C as remembered by the copilot or 23° C as determined by the Safety Board's Senior Meteorologist is appropriate to use for takeoff performance calculations at H44.

.

[5] For the conditions at the accident site, a dry adiabatic lapse rate of 3° C/1000 feet is used in Addendum 1 – Meteorological Factual Report (footnote 3),.

Attachment 1

Sky Connect Data

registration	Longitude (deg)	Latitude (deg)	Speed (kts)	Heading (deg true)	Altitude (ft)	Local time
N612AZ	-122.8043	40.7870	0	0	3284	19:21:14
N612AZ	-122.8040	40.7818	76	213	3524	19:23:20
N612AZ	-122.9578	40.8090	115	297	6148	19:26:59
N612AZ	-123.0508	40.8417	134	292	5469	19:29:11
N612AZ	-123.1420	40.8772	119	289	4423	19:31:20
N612AZ	-123.2233	40.9010	122	322	6302	19:33:26
N612AZ	-123.2522	40.9142	0	138	5945	19:35:32

Attachment 2 Spectrum Graphs

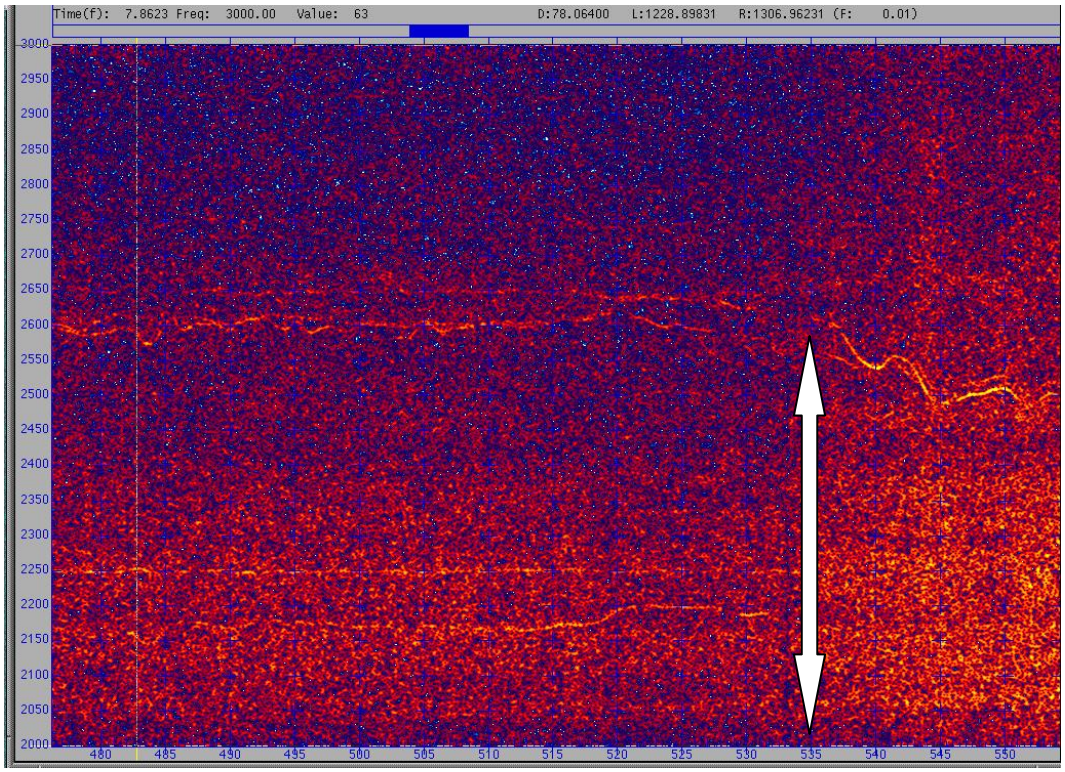

Figure A2.1 – Power decrease just after crossing 7000 foot ridge west of Trinity base
535 seconds = 19:28:33

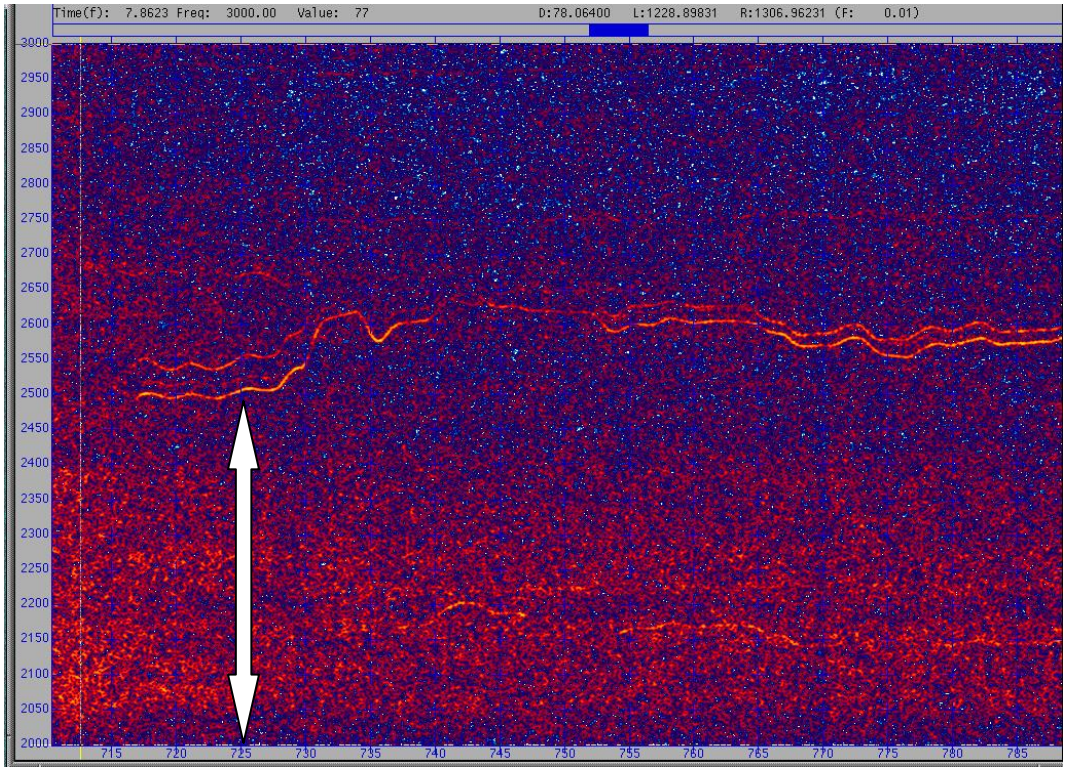

Figure A2.2 – Power increase to start climb from 4000 feet to cross saddle 725 seconds = 19:31:43

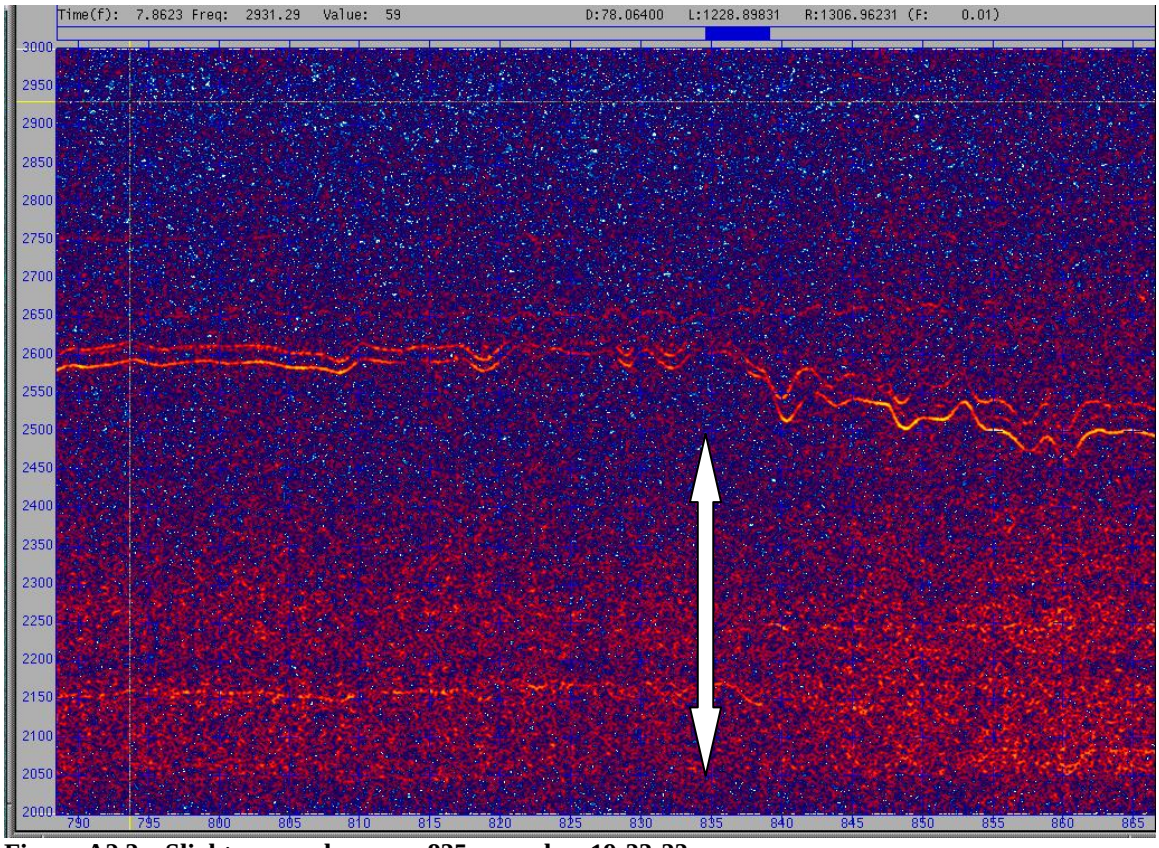

Figure A2.3 – Slight power decrease 835 seconds = 19:33:33,

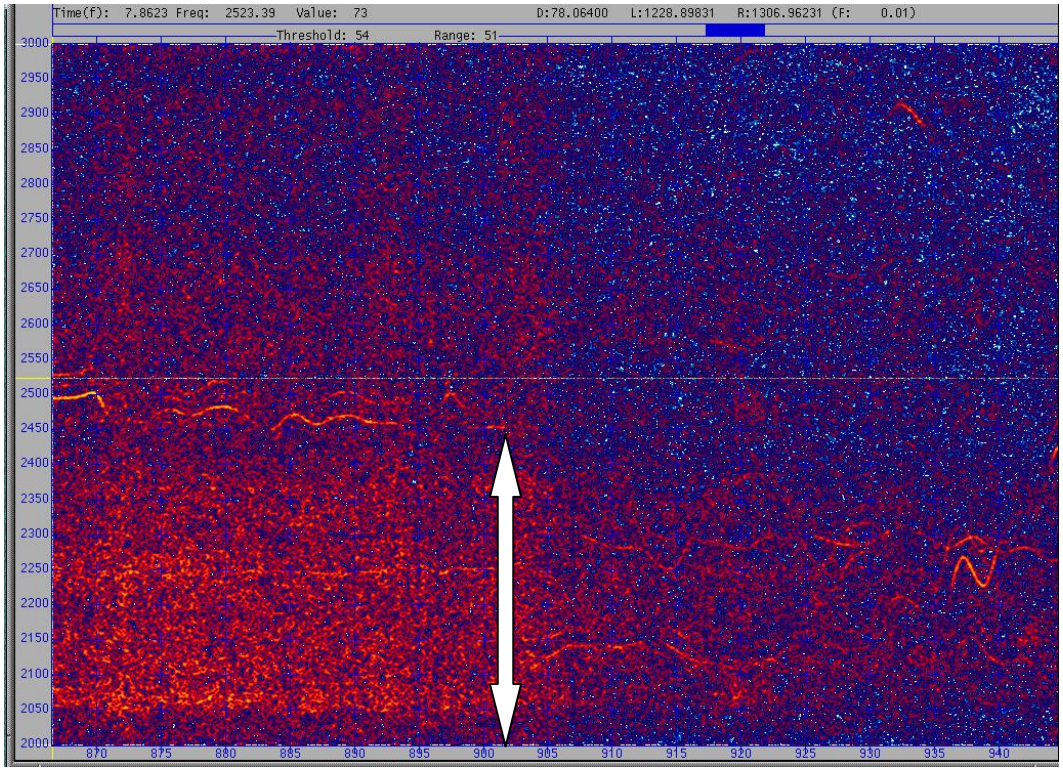

Figure A2.4 - Power decrease after crossing ridge near H44 902 = 19:34:40

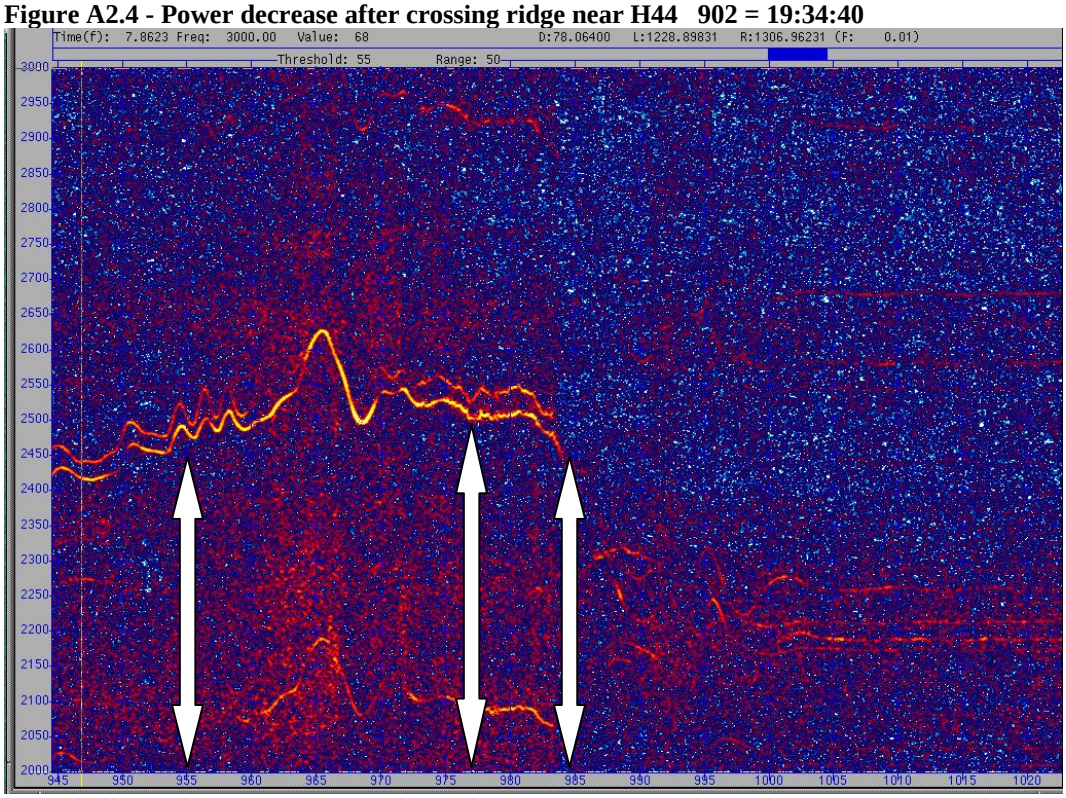

Figure A2.5 – At touchdown zone H44 955 = 19:35:33
Solid, aircraft is not rolling 977 = 19:35:55
Power decrease H44 985 = 19:36:03

Attachment 3
Summary of Events, Timing, Distances and Speeds

DELTA
1178

	CVR SKY SPECTRUM EVENT	HR	CVR AND SKY CONNECT MIN	SEC		TOTAL SEC	SPECTRUM
SKY, CVR	POWER DOWN AT H44		19	36	3	2163	985
CVR	"HERE WE COME STRAIGHT DOWN HERE"			35	37	2137	959
SKY	AT TD ZONE			35	32	2132	954
SPEC	POWER UP			35	21	2121	943
CVR	"WE ARE AT 20 DEGREES"			34	53	2093	915
CVR	"BE ADVISED WE AT 20"			34	43	2083	905
SPEC	POWER DOWN			34	40	2080	902
CVR	"DOWN LEFT DOWNWIND SLOWIN DOWN"			34	40	2080	902
CVR	"STARTING OUR APPROACH"			34	16	2056	878
CVR	"SHOULD BE RIGHT OUT AT OUR 10 OCLOCK "YOU CAN FLY PAST IT AND COME BACK AROUND"			34	10	2050	872
				33	52	2032	854
CVR	"CUT RIGHT TO EDGE OF SMOKE UNTIL I CAN PICK UP THE RIDGE"			33	47	2027	849
CVR	" STOP TURN RIGHT OFF YOUR NOSE"			33	41	2021	843
CVR	"GUNNA COME RIGHT...BETTER VISIBILITY"			33	34	2014	836
CVR	"YUP WE'RE AT 6000 FT NOW"			33	31	2011	833
SKY	6302 FT SKY			33	26	2006	828
CVR	"GOING FOR THAT SADDLE RIGHT THERE"			31	41	1901	723
CVR	"WHY AM I DOWN TO 4000"			31	39	1899	721
SKY	4300 SKY CONNECT			31	20	1880	702
CVR	"STILL 8 MILES OUT"			30	16	1816	638
SKY	5469 134 KTS SKY			29	11	1751	573
SPEC	POWER DOWN			28	33	1713	535
SKY	6149 115 KTS SKY			26	59	1619	441

SKY CONNECT DATA
CVR BASED DATA

Figure A3.1 – Key events derived from the CVR and SkyConnect data.

TIME/DISTANCE CALCULTIONS

		HR	MIN	SEC	TOTAL SEC	SPEED KNOTS	DELTA TIME SEC	AVERAGE SPEED KNOTS (EST)	DISTANCE NM
SKY	AT TD ZONE	19	35	32	2132	0			
							10	15	0.04
CVR	"GOT MY SPOT"		35	22	2122	30			
							20	40	0.22
GOOGLE	1/4 MILE OUT (EST)		35	2	2102	50			
							9	57.5	0.14
CVR	"WE ARE AT 20 DEGREES"		34	53	2093	65			
							10	67	0.19
CVR	"BE ADVISED WE AT 20"		34	43	2083	69			
							3	69.25	0.06
SPEC/CVR	POWER DOWN "SLOWIN DOWN"		34	40	2080	69.5			
							12	69.75	0.23
GOOGLE	CROSS RIDGE (EST)		34	28	2068	70			
							18	70	0.35
CVR	"SHOULD BE RIGHT AT OUR 10"		34	10	2050	70			
							39	88	0.95
CVR	"YUP WE'RE AT 6000 FT NOW"		33	31	2011	120		88 is not straight line average	
							5	121	0.17
SKY	6302 FT SKY		33	26	2006	122			
							126		2.36
	SKY CONNECT DATA						0.89	ridge loop (nm)	
	CVR BASED DATA						1.47	from SKY to ridge (nm)	
	POSITION DATA								

Figure A3.2 – Time/distance calculations.

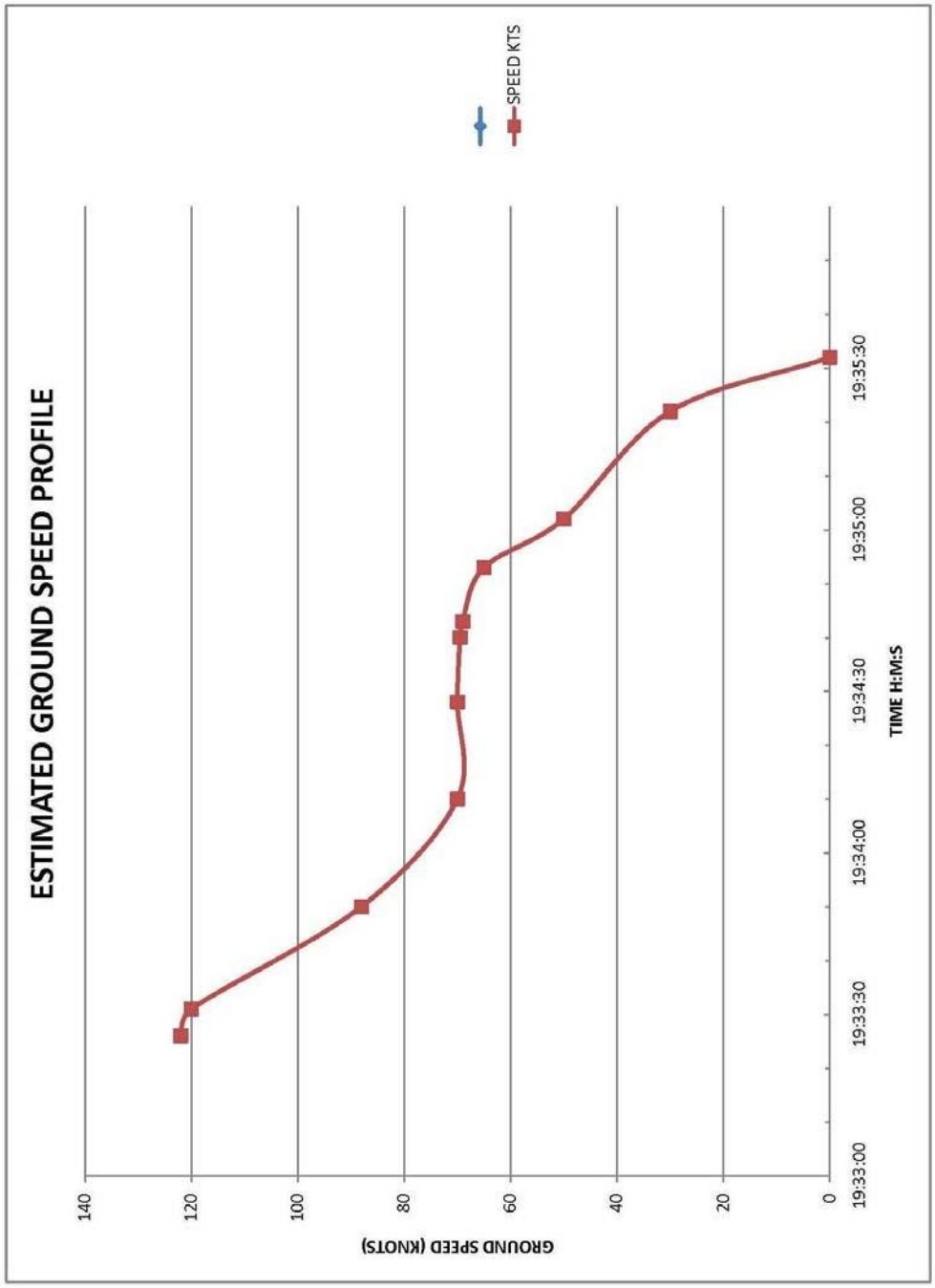

Figure A3.3 – Recorded and estimated ground speeds.

Attachment 4
Google Earth snapshots of events

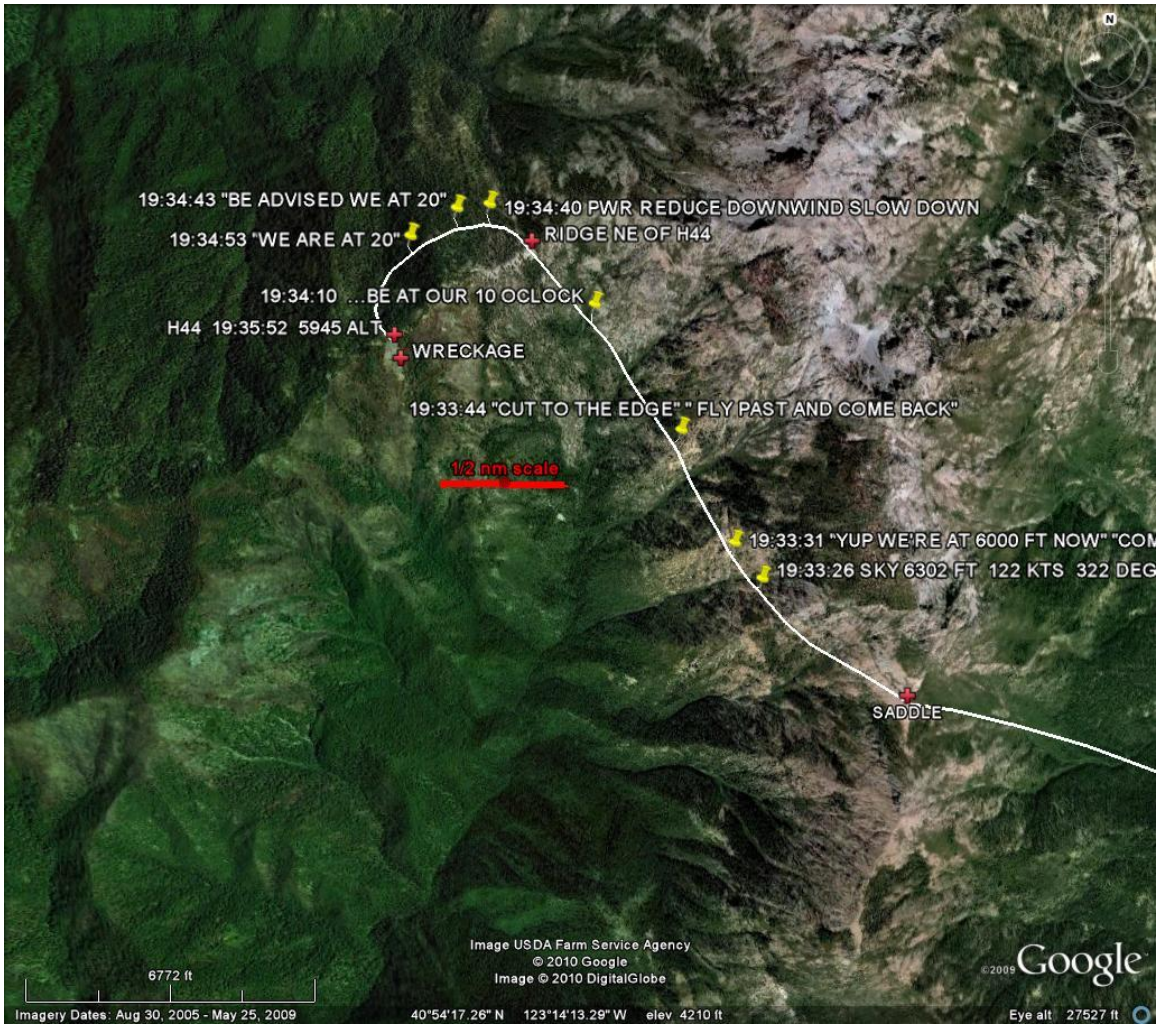

Figure A4.1 - Overview

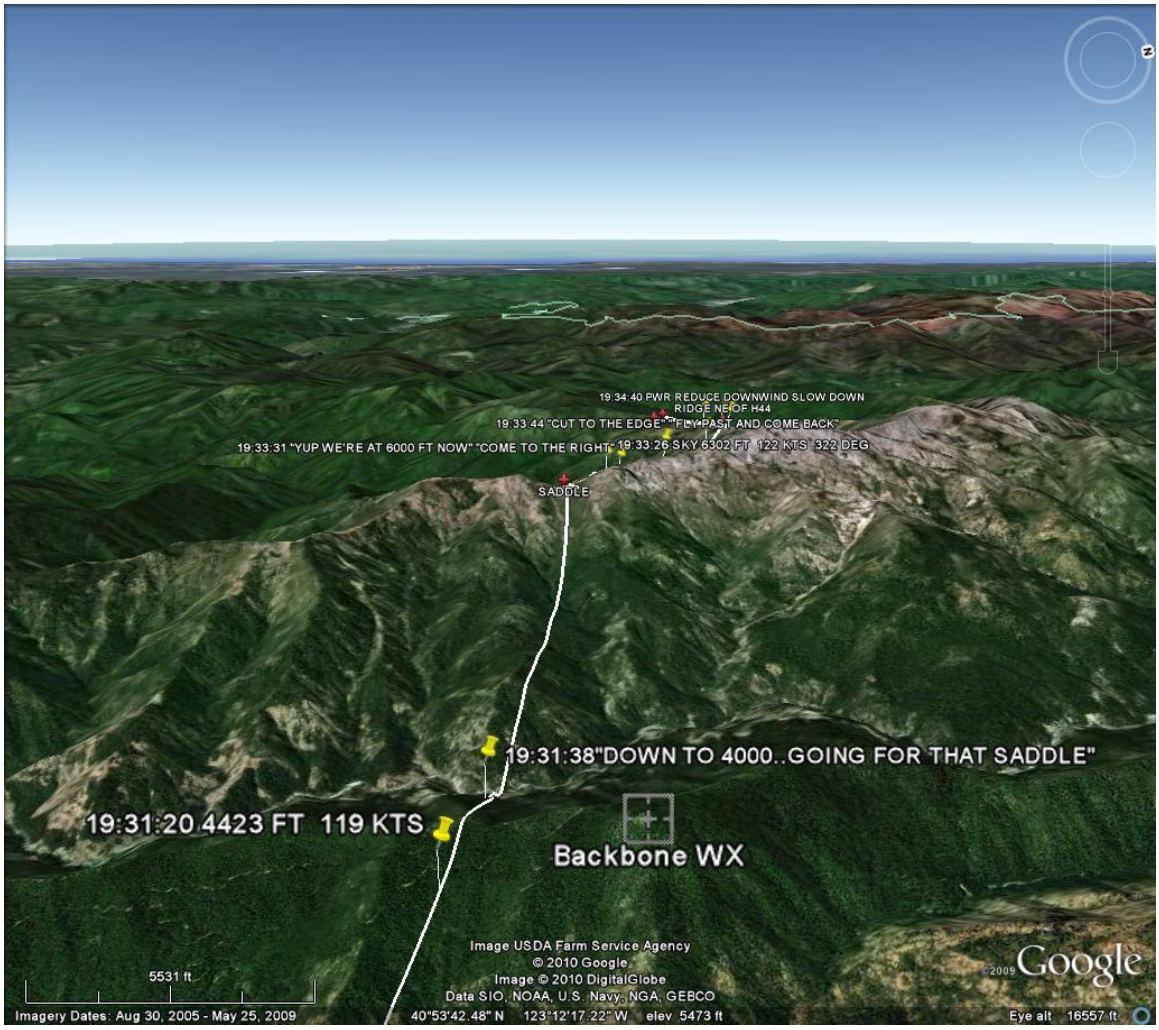

Figure A4.2 – Going for that saddle 19:31:41

Figure A4.3 – Come to the right 19:33:31

Figure A4.4 – Be at our 10 O'clock 19:34:01 H44 can be seen further west, down the ridge.

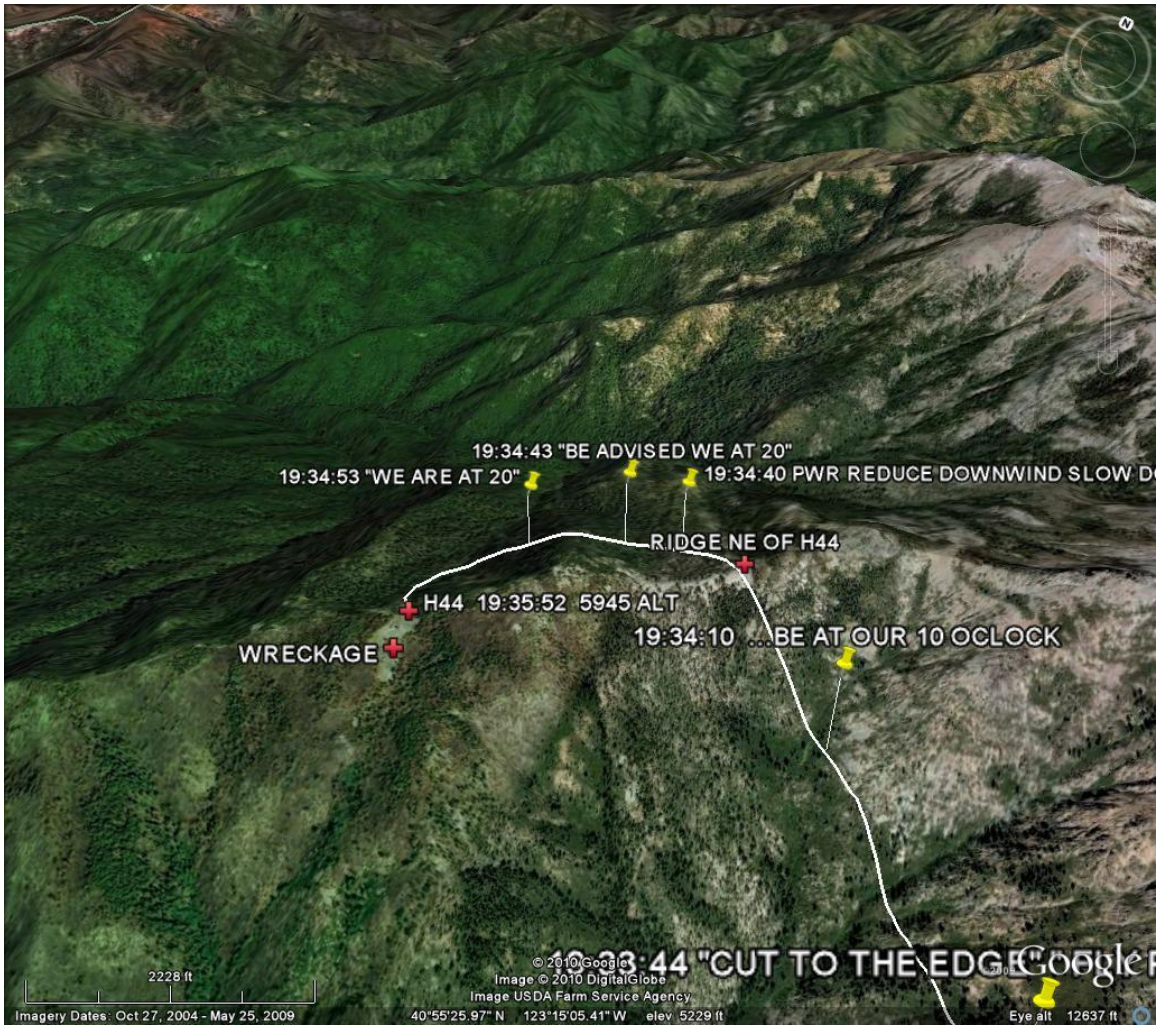

Figure A4.5 – Crossing the ridge, reducing power, calling 20 degrees, starting at about 19:34:30

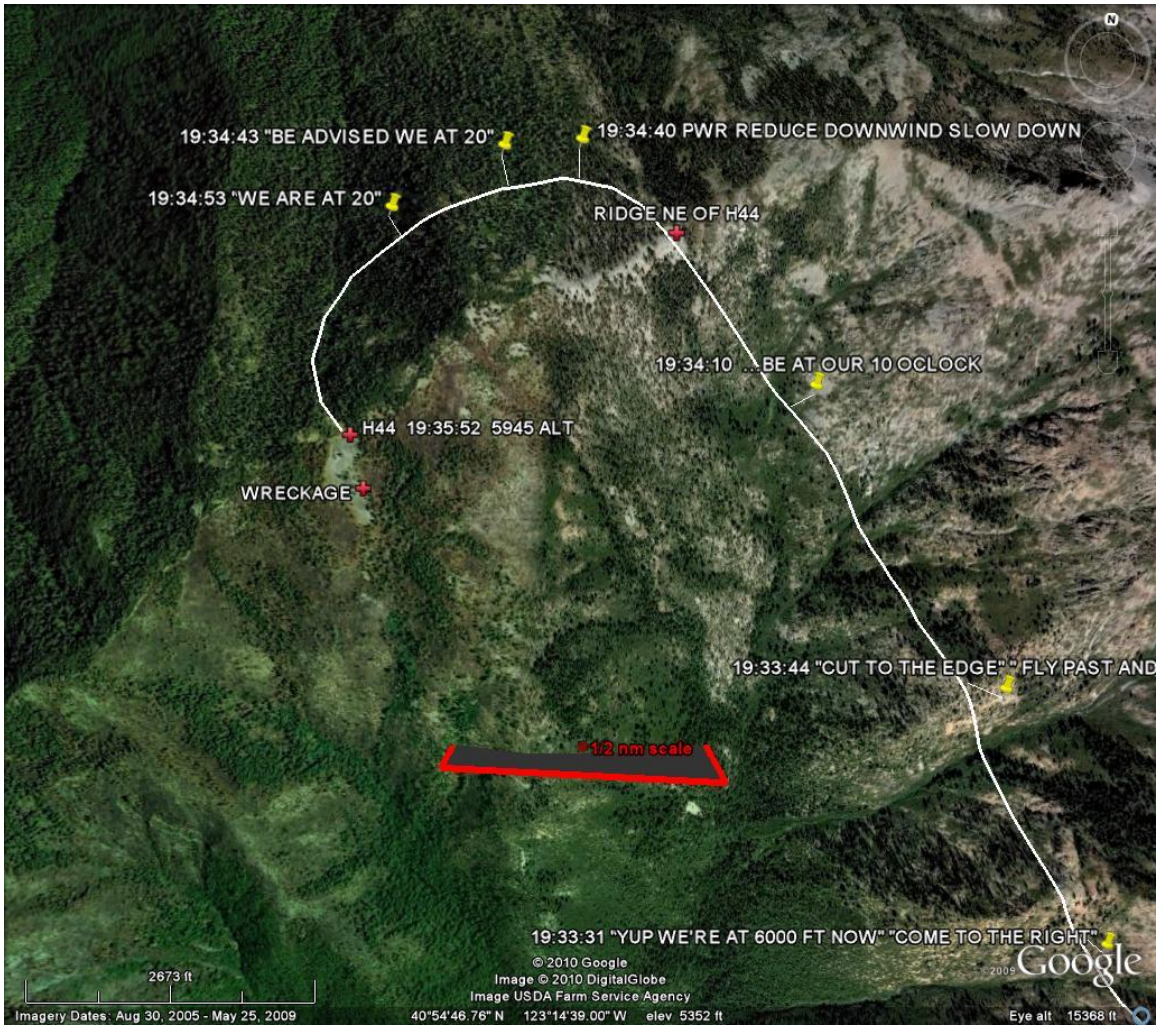

Figure A4.6 - Overview