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Eidgenössische Flugunfallkommission  
Commission fédérale sur les accidents d'aviation  
Commissione federale sugli infortuni aeronautici  
Federal Aircraft Accident Board

# **Final report No. 1812 of the Federal Aircraft Accident Board**

**concerning the incident (Airprox)**

between SWR974 and AZA567

on 6 December 2002

9 NM SW KLO VOR

This final report has been prepared of the Federal Aircraft Accident Board according to art. 22 – 24 of the Ordinance relating to the Investigation of Aircraft Accidents and Serious Incidents (VFU/SR 748.126.3), based on the Investigation Report by the Aircraft Accident Investigation Bureau on 22 June 2004.

This report has been prepared for the purpose of accident prevention. The legal assessment of accident causes and circumstances is no concern of the accident investigation (art. 24 of the air navigation law, dated December 21, 1948, LFG, SR 748.0).

# FINAL REPORT

## AIR TRAFFIC INCIDENT REPORT (ATIR)

### AIRPROX (NEAR-MISS)

THIS REPORT HAS BEEN PREPARED FOR THE PURPOSE OF ACCIDENT/INCIDENT PREVENTION. THE LEGAL ASSESSMENT OF ACCIDENT/INCIDENT CAUSES AND CIRCUMSTANCES IS NO CONCERN OF THE INCIDENT INVESTIGATION. (ARTICLE 24 OF THE AIR NAVIGATION LAW)

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PLACE/DATE/TIME	9 NM SW KLO VOR, 6 December 2002, 06:47 UTC
AIRCRAFT	SWR974, RJ1H, HB-IXX, Swiss International Air Lines Zurich – Berlin Tegel  AZA567, E145, I-EXMG, Alitalia Express Zurich – Milan Malpensa
ATC UNIT	Departure Control (DEP)
AIR TRAFFIC CONTROLLERS	DEP (Departure Controller)
	ADC (Aerodrome Controller)
AIRSPACE	C

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## HISTORY

On the morning of 6 December 2002, an airprox occurred 9 NM south-west of Zurich Kloten Airport involving two aircraft which had previously taken off from runway 28 at Zurich Kloten.

SWR974, an RJ1H, was en route on a scheduled flight from Zurich to Berlin Tegel. The flight crew of SWR974 had been allocated a BODAN 4Y standard instrument departure (SID). About 90 seconds after take-off and after the flight crew had made contact with Departure Control (DEP), it was cleared, after reaching 5000 ft/QNH, to initiate a left turn towards ZUE VHF omnidirectional radio-range (ZUE VOR) and to continue climbing to FL (flight level) 110. At this time, the aircraft was passing 3900 ft/QNH in a climb. About 30 seconds later it had reached 5000 ft/QNH and in accordance with the clearance received it initiated a left turn towards ZUE.

AZA567, an E145 on a scheduled flight with destination Milan Malpensa, took off 86 seconds after SWR974, also from runway 28, in accordance with the GERSA 3Y SID allocated to it. This aircraft took off at about the time as SWR974, flying in front, received the above-mentioned clearance to execute a left turn towards ZUE. AZA567 also received further clearance from the DEP ATCO to climb to FL 110, immediately after first contact on this frequency.

Soon after the take-off of this second aircraft the DEP controller (ATCO) realised that the situation was not evolving optimally, in that SWR974 was climbing at a lower rate of climb (ROC) than he had expected and at the same time AZA567, which had taken off after it, was flying at a higher rate of climb than he had assumed. As a result of this development, the DEP ATCO realised that in the absence of corrective measures, separation could not be maintained. He therefore instructed AZA567 to change heading to 250°, which AZA567 executed after a short delay. Seconds later the DEP ATCO had to acknowledge that this corrective measure to maintain minimum separation would not be sufficient, which is why he issued AZA567 with traffic information concerning SWR974 and shortly afterwards requested SWR974 to increase its rate of climb.

By this time SWR974 had completed its left turn. The two aircraft were approaching each other laterally offset by just 2 NM; SWR874 was flying about 500 ft higher than AZA567. Almost simultaneously, an STCA (Short Term Conflict Alert) was triggered on the DEP ATCO's radar monitor and SWR974 reported a TCAS (Traffic Collision Avoidance System) instruction to climb. The CMD, as PF (pilot flying), obeyed this by switching off the autopilot and auto-throttle and setting maximum power. In this way it was possible to increase the ROC so that the value of the climb rate on the VS/TCAS indicator (device indicating vertical speed - climb performance) went into the green.

The flight crew of AZA567 received a TCAS-RA "Adjust vertical speed adjust", which they obeyed. At the same time, on the basis of the traffic information from the DEP ATCO, they made visual contact with the opposing SWR974.

The aircraft finally passed each other at a minimum lateral separation of 1.7 NM and a simultaneous altitude difference of 600 ft.

Subsequently, both the air traffic control company skyguide and Swiss International Airlines submitted an ATIR to the AAIB.

All times are specified in the universal time coordinated format – UTC (local time – 1 hour)

## FINDINGS

- Both aircraft were flying in Class C controlled airspace.
- Both aircraft were flying according to instrument flight rules (IFR) and were in uninterrupted radio contact with departure control.
- At 06:44:37 SWR974 took off from runway 28 with SID BODAN 4Y and an initial climb clearance to FL 80.
- At 06:46:03 AZA567 took off from runway 28 with SID GERSA 3Y and an initial climb clearance to FL 80.
- At 06:46:06 SWR974 received the following clearance from DEP: "SWR974, passing five thousand feet left hand to Zurich East, climb to flight level 110". The Swiss flight crew confirmed this clearance correctly.
- At 06:46:53 AZA567 made contact for the first time on the DEP frequency and immediately received the clearance: "AZA567, radar contact, climb to flight level 110". The Alitalia flight crew confirmed this clearance correctly.
- At 06:47:25 DEP asked AZA567 to make the following change in heading: "AZA567, fly heading 250". The flight crew confirmed this instruction correctly after querying it once. At the time of the definitive confirmation of this instruction by AZA567, SWR974 had practically completed its left turn and was heading for ZUE, whilst AZA567 was flying on a south-westerly heading in accordance with its SID.

At this time, i.e. 40 seconds after AZA567's first contact with the DEP ATCO, the minimum IFR separation from SWR974 flying in front of it had already been violated. The lateral distance between the two aircraft was still 2.9 NM, though the two aircraft were closing rapidly laterally offset on reciprocal tracks, their altitude difference was 600 ft.

- At 06:47:35 the DEP ATCO issued the following traffic information to AZA567: "AZA567, be advised, Jumbolino climbing eastbound, about your ten o'clock, distance two miles".
- At 06:47:39 an STCA appeared on the DEP ATCO's radar monitor.
- At 06:47:43 the DEP ATCO requested SWR974 to increase its rate of climb. The lateral separation between the two aircraft was now 2.1 NM with an altitude difference of 500 ft.
- At 06:47:46 SWR974 responded to this request with: "974, we have TCAS climb".
- At 06:47:50 AZA567 reported that it had the opposing Jumbolino "in sight". Shortly afterwards, the two aircraft passed each other with a lateral separation of 1.7 NM and an altitude difference of 600 ft.
- The functions of ADC1 and ADC2 (aerodrome control) were coupled at the time of the incident.
- According to the written statement by the Chief of Operations TWR/APP, the case in question was a "repetitive incident in connection with the climb performance of an RJ1H", which had demanded immediate measures (see "Measures Taken"). At the same time, he also stated that "the greatest possible efficiency is expected within the framework of safe handling of traffic and compliance with the regulations in force. This also includes turning east after passing 5000 ft/QNH". He also mentioned that ATCOs were not instructed in the performance characteristics of aircraft types newly introduced in Zurich because the airlines would operate the same aircraft type differently.

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- The ADC ATCO stated that he considered the TACO take-off separation proposals (TACO – Tower Approach Coordination – screen display of “electronic” control strips) as guide-lines. He assessed the flight progress of the aircraft which had taken off first, noted the performance and exit gates of the aircraft concerned and, where applicable the weather conditions. In this context, his objective was to hand over the aircraft which had taken off to DEP with radar separation. In the present case, with the aircraft types involved, the take-off separation would have to have been increased in comparison with a situation involving two aircraft with similar performance. Empirically, in such a situation a take-off interval of about 100 to 120 seconds would apply.
- For these two flights, TACO had calculated and proposed a take-off separation of 120 seconds. The actual take-off separation was 86 seconds.
- According to his interview, the DEP ATCO was expecting poor climb performance from SWR974 during the departure in a westerly direction and a substantially better ROC as soon as this aircraft had completed the left turn as directed and was flying in an easterly direction. He justified his assumption on the prevailing wind situation.
- Weather: INFO NOVEMBER  
QAM LSZH 0620z  
Wind: 040°, 12 knots  
Ground visibility: 8 KM  
Cloud: SCT at 900 ft/GND, BKN at 1300 ft/GND  
Temperature: +05°C, dewpoint +03°C  
QNH 1017 hPa  
NOSIG  
  
Wind at 5000 ft/QNH: 070°, 20 knots  
Wind at FL 70: 080°, 25 knots

## ANALYSIS

### Determination of take-off intervals using TACO

TACO is an interactive on-screen display of “electronic” control strips. The system is used primarily for “quiet” coordination between the workstations in the control tower and those in Arrival and Departure respectively. However, certain workstations in ACC (Area Control Centre) are networked into the system.

The functionalities of the system for coordination between the tower and departure control also include calculation of optimum staggering of consecutive departures on the different take-off runways. In this context the system controls a built-in 84 by 84 matrix. This matrix takes into account the performance characteristics of aircraft types on the basis of a classification into weight classes as well as the envisaged take-off runway and the allocated SID of each individual take-off. On this basis the system has available more than 7056 variations of chronological take-off intervals, which are used as proposals for the on-screen display. The basis of this calculation is the take-off sequence entered manually by controllers. This time-related information is calculated internally in TACO with an accuracy of the order of one second. The proposed take-off intervals are displayed in steps of whole minutes (rounded off). ATCOs can change the displayed take-off intervals manually and thereby allow empirical values to be integrated.

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**The performance characteristics of the RJ1H in connection with the specific Swiss departure procedure from runway 28 for departures into the east sector**

The RJ1H is characterised by very good airfield performance. On the other hand, its ROC is rather limited. For about five years, for departures from runway 28 with exit gates in the east sector, the company procedures of Swiss (formally Crossair) for this aircraft type have recommended take-offs with an 18° flap setting (instead of 24°). This recommendation is based on the one hand on reasons related to noise abatement and on the other hand on reaching 5000 ft/QNH as quickly as possible. This creates the requirement for ATC (air traffic control) to be able to build in an early left turn to the east, thereby achieving a shorter flight path. Application of this procedure means that the ROC is distinctly higher than that which would apply to a take-off with a 24° flap setting, and the airspeed is also some 10 kt higher. The ROC in this configuration is about 1500 to 2000 ft/min and the airspeed is about 150 KIAS. Clean-up is initiated once 5000 ft/QNH has been reached, i.e. the airspeed is successively increased to 210 KIAS, in order then to be able to retract the flaps. After this procedure, climb performance increases markedly. A further acceleration phase then follows above FL 80.

On the day of the incident, in terms of its load and climb performance, the HB-IXX as SWR974 corresponded to a thoroughly average or typical flight.

**The performance characteristics of the E145**

The E145 is an aircraft which has high power reserves, above all in the initial climb. During the initial climb, airspeed is limited by overspeed protection to 240 KIAS up to an altitude of 8000 ft pressure altitude. In a normal RNAP (Required Noise Abatement Procedure) climb profile, Alitalia flight crews maintain an airspeed of V<sub>2</sub>+10 kt up to an altitude of 3000 ft/AAL. In the present case, this meant an airspeed of about 142 KIAS. After reaching 3000 ft/AAL the aircraft is accelerated during clean-up to a speed of 240 KIAS. In the initial climb, up to an altitude of 8000 ft, the E145 achieves an ROC of at least 3000 ft/min. In the case of a low departure weight, it may even reach 4-5000 ft/min.

On the day of the incident, in terms of its load and climb performance, the I-EXMG as AZA567 corresponded to a thoroughly average or typical flight.

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### The ADC ATCO's handling of the take-off intervals calculated by TACO

The following table gives a summary of the calculated and actual take-off intervals of a number of departures before and after the incident:

ICAO flight number	Calculated take-off interval according to TACO in seconds	Actual take-off interval in seconds	Difference in seconds
SWR1050	180	120	-60
SWR82LV	Not relevant, since take-off 16		
DLH5535	Not relevant, since take-off 16 beforehand		
SWR1726	120	79	-41
SWR724	120	99	-21
SWR1164	behind	behind	
SAS600	180	99	-81
<b>SWR974</b>	180	105	-75
<b>AZA567</b>	<b>120</b>	<b>86</b>	<b>-34</b>
SWR786	60/180	59/145	-1/-35
SWR1036	120	89	-31
SWR1574	120	86	-34
SWR632	120	91	-29
BAW709Q	120	84	-36

The results of this summary indicate that in this sequence of 14 consecutive departing aircraft the take-off intervals were virtually all shorter than the calculated intervals. The differences include values which are 45% below the setpoints. Though this type of handling does indeed increase efficiency substantially, it nevertheless conceals the danger that, as in the present example, minimum IFR separation is lost soon after take-off. Furthermore even minor irregularities may mean that traffic can no longer continue to be handled safely.

In the present case, the ADC ATCO did not take into consideration the fact that the Alitalia E145 which was taking off next had distinctly better climb performance and a slightly higher average airspeed in the initial climb. At the time of his interview, he was able to provide only incomplete information on the performance characteristics of the aircraft types involved. The ADC ATCO also did not take into account the fact that the flight path of AZA567 according to its SID GERSA 3Y route was some 15° more to the south than that of SWR974. This circumstance meant that the flight paths of the two aircraft would come very close to each other laterally after SWR974 had started its envisaged left turn.

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Viewed overall, an increase in the take-off interval would even have been justified in this situation. As a minimum, however, the TACO proposal should have been fully complied with.

### **Handling of the impending conflict by the DEP ATCO**

The DEP ATCO has an identical screen display of take-off intervals calculated by TACO to that of the ADC ATCO. According to his statement, he realised soon after the take-off that the situation was not evolving optimally. He assumed that the instruction he gave to AZA567 to change heading to 250° would be more effective than stopping the climb of this aircraft. At the beginning of the conflict he was also hardly aware that AZA567's SID GERSA 3Y was routed 15° more to the south than the SID of SWR974. His expectations of the climb performance of both aircraft types deviated considerably from the actual conditions. He made an error in his estimation of the effect of the wind. Prevailing winds affect the climb gradient, not the ROC.

Actually, in the situation in question, only a radical intervention ("...stop your climb immediately...") of AZA567's climb immediately after first contact with DEP could have maintained separation. Other possible precautionary measures, such as instructing AZA567 to make a sharp right turn, would have led to a violation of the noise abatement procedure.

The corrective measures taken by the DEP ATCO proved to be insufficiently effective to prevent a pronounced violation of the minimum IFR separation. Issuing traffic information to AZA567 concerning the opposing SWR974 eased the conflict somewhat.

Both air traffic controllers stated that they had not been instructed in the performance characteristics of newly introduced aircraft types.

### **The practice of an early east turn for departures from runway 28 with exit gates in the east and the consequences of this practice**

The departure control procedure described above, which involves instructing departing aircraft to make an early east turn after taking off from runway 28 once they have reached 5000 ft/QNH, corresponds to the generally customary practice and expectations of both sky-guide management and customers. The demand for the greatest possible efficiency, however, requires detailed knowledge of the performance characteristics of aircraft types which ATCOs do not possess and in which they are not instructed. Certain factors which greatly affect the performance of an aircraft, above all in the phase following take-off (e.g. take-off mass or special departure procedures), are not known by ATCOs either. The above-mentioned circumstances led to a conflict of goals which affected the present case.

In any event, the DEP ATCO must be able to rely on approximate compliance with the departure conditions according to the TACO proposal in order to allow him to plan and implement a traffic concept. He must be able to assume that the take-off interval is chosen by the ADC ATCO in such a way that the necessary minimum IFR separation is initially guaranteed on application of the usual procedures after hand over of aircraft which have taken off. The considerably shortened take-off interval compared with the TACO proposal had not been discussed with the DEP ATCO.



## CAUSE

The incident has to be attributed to the fact that the DEP ATCO gave to SWR974 an early clearance to initiate a turn in relation with the short take-off interval allocated by the ADC ATCO to the following AZA567 so that the required separation was no longer maintained. Thereby none of the two ATCOs involved took precautionary measures to avoid a separation infringement.

The following additional factors contributed to the incident:

- The ATCOs' inadequate knowledge of the performance characteristics of the aircraft types involved.
- Inadequate corrective measures after recognition of the conflict by the DEP ATCO.

## SAFETY RECOMMENDATION NR. 276

The Federal Office for Civil Aviation should arrange for air traffic controllers to be instructed in the performance characteristics of newly introduced aircraft types. Furthermore, instruction in the performance characteristics of the most frequently used aircraft types should be repeated regularly.

*Comment: A similar incident had already occurred in Zurich on 13 August 2001, in which inadequate knowledge of the performance characteristics of the aircraft types involved played a part. On that occasion, the AAIB issued a similar safety recommendation.*

## MEASURES TAKEN

On 19 December 2002 the Chief of Operations TWR/APP Zurich issued an instruction according to which departure release behind RJ1H/RJ85/RJ70 aircraft in the direction of BODAN/BAMUR on runway 28 for the following jets and turboprops shall be as follows:

- 5000 ft/QNH
- TACO separation proposal + 1 minute.

Berne, 1 September 2006

**Federal Aircraft Accident Board**

André Piller, President

Tiziano Ponti, Vicepresident

Ines Villalaz-Frick, Member

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## Transcript of Original Tape Recording

Subject        **AIRPROX SWR974 of December 6, 2002**

Call Signs	<b>974</b>	→	<b>SWR974</b>	→	<b>Swiss (Swiss Air Lines)</b>
	<b>567</b>	→	<b>AZA567</b>	→	<b>Alitalia</b>
	600	→	SAS600	→	Scandinavian
	786	→	SWR786	→	Swiss (Swiss Air Lines)
	DEP	→	Zurich Departure Sector Controller		

Frequency      Zurich Departure Sector Radar / DEP 125.950 MHz

The signer certifies the completeness of the present transcript

**skyguide**  
Flugsicherungsbetrieb Zürich

ZZDA

sig. Bettina Comte

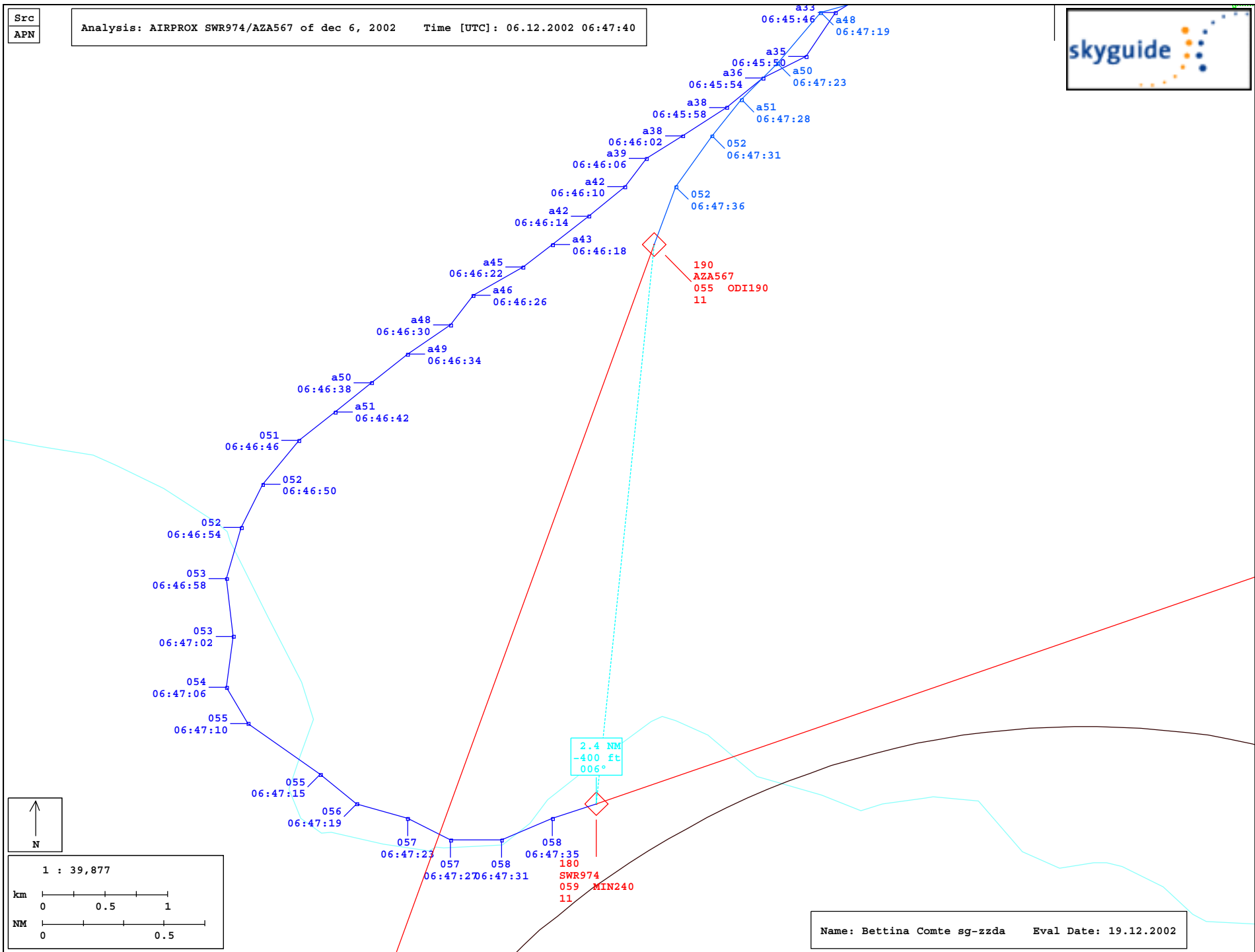
To	From	Time UTC	Communication	Observation/various 2
DEP	974	06:45:00	Departure „guete Morgä“, SWR974, passing two thousand four hundred to level 80	
974	DEP	:06	SWR974, radar contact	
DEP	974	:08	*.....	*mike click
600	DEP	:42	SAS six hundred, turn left to MINGA	
DEP	600	:45	left to MINGA, SAS six hundred	
974	DEP	:46:06	SWR974, passing five thousand feet left hand to Zurich East, climb to flight level 110	
DEP	974	:11	passing five thousand left to Zurich East and we climb level 110, SWR974	
600	DEP	:15	SAS six hundred, high speed approved	
DEP	974	:18	...974	
974	DEP	:19	thank you	
600	DEP	:20	SAS six hundred, high speed approved	
DEP	600	:22	accelerating high speed, SAS six hundred	
DEP	567	:53	Radar, good morning, AZA567, climb 80	
567	DEP	:57	AZA567, radar contact, climb to flight level 110	
DEP	567	:47:00	110, 567	
600	DEP	:15	SAS six hundred, Radar 133 9	
DEP	600	:18	133 9, SAS six hundred, good-bye	
600	DEP	:21	good-bye	
567	DEP	:25	AZA567, fly heading 250	
DEP	567	:29	heading 250, confirm?	
567	DEP	:31	yes, affirm	
DEP	567	:33	250 heading	
567	DEP	:35	AZA567, be advised, „Jumbolino“ climbing east-bound, about your ten o'clock, distance two miles	
974	DEP	:43	SWR974, increase rate of climb till passing 70	
DEP	974	:46	974, we have a TCAS-climb	

To	From	Time UTC	Communication	Observation/various 3
974	DEP	06:47:48	thank you	
DEP	567	:50	in sight the „Jumbolino“, AZA567	
567	DEP	:52	thank you, AZA567	
DEP	786	:55	Departure „grüezi“, SWR786, four thousand one hundred, climbing flight level 80	
786	DEP	:59	SWR786, radar contact	
974	DEP	:48:04	SWR974?	
DEP	974	:06	974, we had a TCAS-climb, äh we are clear of äh traffic right now	
974	DEP	:11	thank you very much, do you need to wright a report on it?	
DEP	974	:14	*yeah, we have to file a report on that, 974	* captain speaking
974	DEP	:17	okay, I'll do the same; direct to Zurich East	
DEP	974	:19	direct to Zurich East, 974	
567	DEP	:21	AZA567, turn left to GERSA	
DEP	567	:24	left hand again, AZA567, to Ber...*	*unreadable
DEP	567	:31	I confirm to GERSA for AZA567?	
567	DEP	:33	AZA567, that is correct	
DEP	567	:35	okay, thank you	
974	DEP	:43	SWR974, contact Radar 133 9, good-bye	
DEP	974	:46	33 9, „schöne Tag“, SWR974	
567	DEP	:50	AZA567, contact 128 05	
DEP	567	:53	128 05, 567, bye	

- end -

Src  
APN

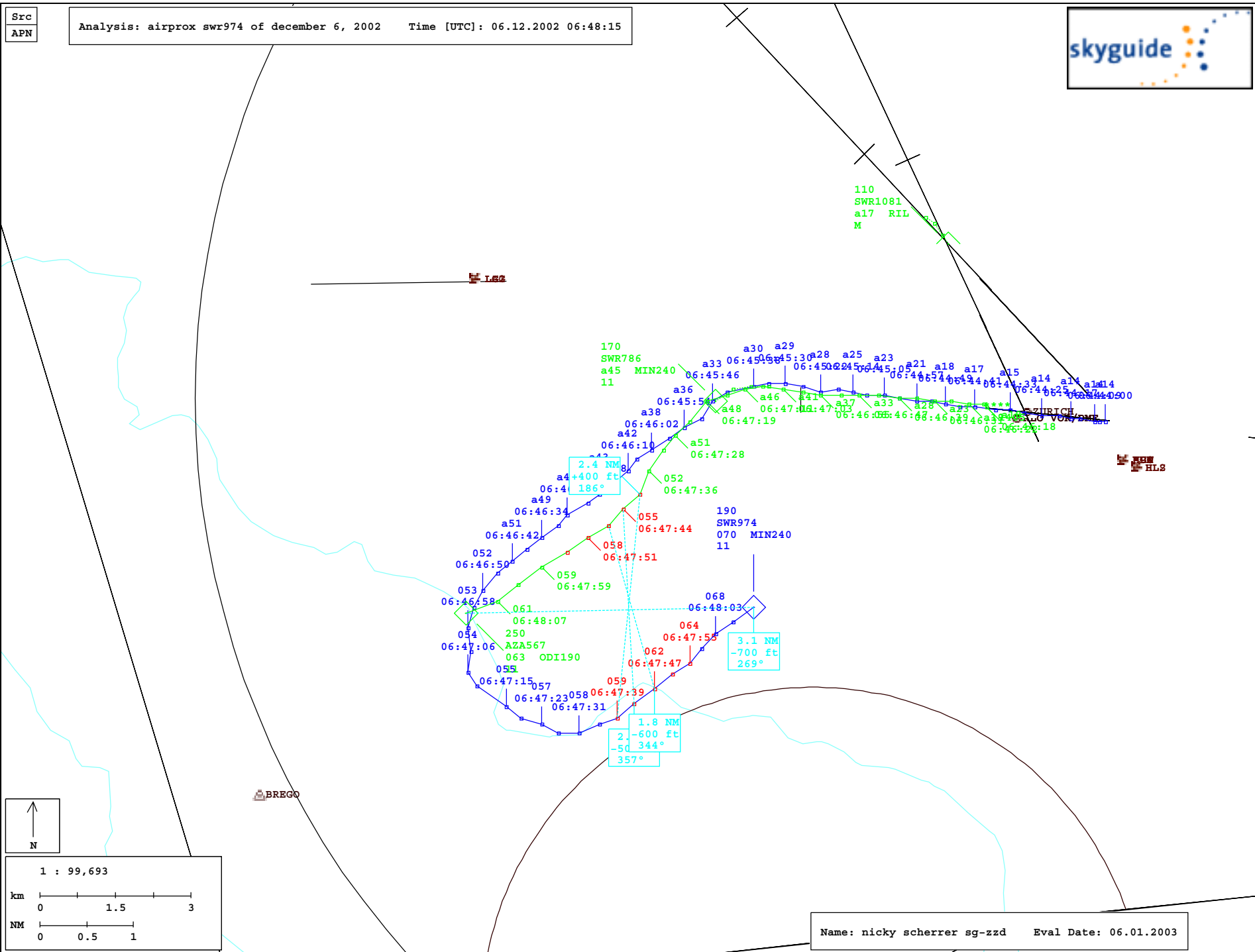
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Name: Bettina Comte sg-zzda Eval Date: 19.12.2002

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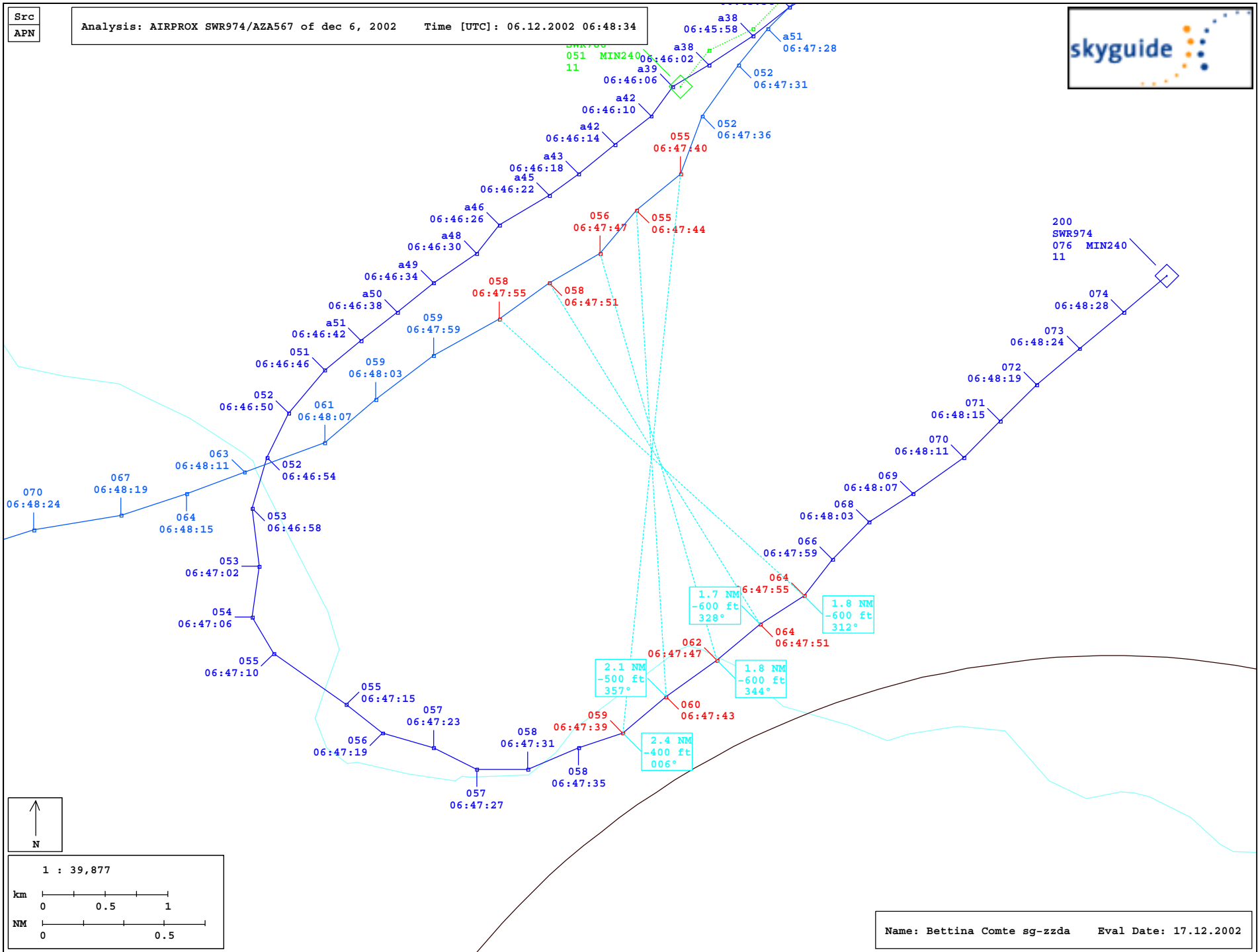
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Name: nicky scherrer sg-zzd Eval Date: 06.01.2003

Src  
APN

Analysis: AIRPROX SWR974/AZA567 of dec 6, 2002 Time [UTC]: 06.12.2002 06:48:34



Name: Bettina Comte sg-zzda Eval Date: 17.12.2002