

Investigation Report

EX010-1-2/05
December 2006

Identification

Type of occurrence: Serious incident
Date: 14 September 2005
Location: Near Frankfurt/Main
Aircraft: 1. Airplane
2. Airplane
Manufacturer / Type: 1. Gulfstream / G-V
2. Boeing Company / Boeing 737
Injuries to persons: No injuries
Damage: Aircraft not damaged
Other damage: None
Information Source: Investigation by BFU

21:11:52 “[call sign] descent flight level 2 5 0 with fifteen hundred or more”

21:11:57 “2 5 0, [call sign]”

Shortly afterward the instruction to establish contact with sector MAN followed.

21:12:02 “[call sign] contact Langen on [frequency], good bye”

21:12:06 “[frequency], good bye”

At 21:12 hrs the Gulfstream crew reported to the sector MAN with the message to be on descent to FL150 and was identified by the responsible ATC controller.

21:12:21 “Rhine control [call sign] out of twenty eight point five for flight level 150”

21:12:33 “Station calling Langen say again please”

21:12:36 “Ah yes that’s [call sign] now out of two eight point one for 150”

21:12:43 “Hello [call sign], identified”

At 21:15 hrs the controller realised the deviation from the original clearance to descent to FL250. He instructed the pilots to climb back to FL250 because of conflicting traffic on FL240. The crew obeyed immediately. The Gulfstream pilot stated later that he had originally been cleared for descent to FL150. He stated further that he had seen the conflicting traffic and, for precautionary reasons, disengaged the autopilot. The traffic collision avoidance system (TCAS) had issued a traffic advisory (TA). It did, however, not issue a resolution advisory (RA).

The Boeing 737 was on a scheduled flight from Munich to Cologne. At 21:09 hrs the crew reported to the ATC controller of the sector MAN with the message of being in FL240. At 21:14 hrs the ATC controller responsible

Factual information

Synopsis

On 14 September 2005 at 21:15¹ hrs an airprox incident between a Gulfstream G-V and a Boeing 737 occurred with a horizontal distance of 0.7 NM and an altitude difference of 300 ft. Prescribed is a distance of 5 NM or 1,000 ft.

History of the flight

The Gulfstream G-V was on a flight according to instrument flight rules (IFR) from Rotterdam to Stuttgart. At 21:11 hrs the responsible air traffic control (ATC) unit, sector FFML, cleared the aircraft for descent to flight level (FL) 250.

¹ Unless otherwise specified, all times are indicated in local time

for the sector MAN instructed the Boeing 737 crew to call sector TAU. The pilots obeyed. Not quite a minute later the now responsible controller realised that conflicting traffic was descending through the Boeing's flight level. He issued the respective traffic information. The crew reported that they had received a TCAS RA to climb and conflicting traffic in sight. The recorded ATC radar data shows that the TCAS RA was carried out immediately.

The short term conflict alert (STCA) protocol showed that the alarm was active between 21:15 and 21:16 hrs.

The flight path of the two aircraft crossed with a horizontal distance of 0.7 NM and a vertical distance of 300 ft. Both aircraft continued their flights and reached their respective destinations safely.

Aircraft information

The Boeing 737 had a German certificate of registration. The crew was also from Germany. The aircraft was equipped with a TCAS unit. It records 16 parameters. It was fully functional and operational. The TCAS data were available to the BFU for the purpose of evaluation (see Appendix).

The Gulfstream had a certificate of registration from the United States of America. The crew was also from the USA. According to the Gulfstream pilot the aircraft was equipped with a TACS. According to his statements TCAS was engaged and seemed to function properly; *"both before, during and after the event, the TCAS appeared to provide correct and appropriate indications of traffic." ... it was set to TA/RA ABOVE AND BELOW. ... when the TCAS generates a Traffic Alert, the range automatically changes to 5 mile range.*

Communication

Radio communications were recorded and available for evaluation.

Flight recorders

The recorded ATC radar data was available as print out.

The Boeing was equipped with a Honeywell SSFDR. It records 245 parameters. The FDR data was available for the purpose of evaluation.

The Gulfstream's FDR data was not available for the purpose of evaluation. Information concerning the functioning of the TCAS unit was available as pilot statements.

Organisations and their procedures

Sector FFML is part of the ATC unit Karlsruhe. It is responsible for the upper airspace. The sectors TAU and MAN are part of the ATC unit Langen and are responsible for the lower airspace. FL245 is defined as border between upper and lower airspace. The sector FFML is above sector MAN and TAU (see drawing).

Transfer of an aircraft from one sector to another occurs shortly before the sector's border is crossed. The aircraft is still within the airspace of the sender sector. The accepting sector takes over the aircraft and allows it to enter his airspace. Distinctions are drawn between horizontal and vertical sector boundaries.

With vertical sector boundaries (adjoining sectors) the overflight and therefore approach of the next sector is unavoidable. With horizontal sector boundaries (sectors are above each other) the aircraft is cleared to the altitude closest to the sector boundary by the ATC controller. Then the instruction to call the next sector is issued. The ATC controller of the new sector assigns a new altitude. In both cases written agreements govern the transfer conditions between sectors.

Additional information

According to NfL I – 258/05 para 7 subpara 5 und AIP GEN 3.4-10 an aircraft operated under IFR which is transferred from one sector to the next has to mention its call sign and the current altitude during its initial call to the new sector. Is it in decent or climb it also has to report the cleared FL.

Analysis

With a distance of 0.7 NM and 300 ft, the prescribed separation of 5 NM lateral and 1,000 ft vertical was significantly infringed during the airprox. A dangerous situation occurred because of the short distance between the two aircraft.

The sector FFML instructed the Gulfstream to leave their cruise level and to descent to FL250 with a vertical speed of 1,500 ft/min. Afterward the FFML controller transferred the aircraft in descent to the sector MAN. It is probable that the Gulfstream pilot mixed up the numbers of the clearance to descent (FL250) with the ones from the descent rate (vertical speed of 1,500 ft/min or more – fifteen hundred or more). It is probable that the result was the conception that they were cleared to descent to FL150. The radio communication transcript showed that a clearance to descent to FL150 was never given to the Gulfstream crew.

The pilot reported to the sector MAN. He did not use the prescribed radio communication procedure. He used the wrong call sign for the aeronautical station ("Rhine Control" instead of "Langen Radar"). He

reported the current altitude as "*out of twenty eight point five*". He added the altitude to which he wanted to descent ("*for flight level 150*"). He used the word "for" which can easily be misinterpreted as the number 4 (English four).

Initially the result was a radio communication composed of a wrong call sign and a set of numbers which was not understandable for the ATC controller. Once the controller asked who had called, the Gulfstream pilot answered again, this time without using the call sign. However, he repeated the current ("*now out of two eight point one for 150*") and the cleared altitude. The controller did not realise the deviation from the original clearance to descent to FL250. He expected, however, that based on the transfer agreements between sectors the descent would end in FL250. So that he did not verify the altitude any further. Thus the Gulfstream pilot could assume that he could descent to FL 150.

The instruction to descent including a limitation of the rate of descent given to the Gulfstream crew by the sector FFML was a multiple instruction which might have contributed to the confusion of flight levels.

At this time the Boeing 737 was in FL240 on almost opposite course to the Gulfstream. The transfer agreement between sector FFML and sector MAN provided that the ATC controller of sector FFML would clear the aircraft to the lowest possible altitude – in this case FL250. Then the frequency change would occur. The ATC controller of sector MAN would then issue a new, lower altitude and thereby permit the aircraft to enter his sector. The ATC controller expected that the Gulfstream was cleared to FL250 and that they would stop their descent accordingly. Thus he did not have any reason to keep the Boeing 737 on his frequency. He instructed the Boeing 737 crew to call sector TAU. Half a minute later the ATC controller of sector MAN realised that the Gulfstream had not stopped the descent in FL250 but continued to descent. STCA generated an alarm on the controller's radar monitor also. He immediately instructed the Gulfstream crew to stop their descent and to climb back to FL250. The crew complied without delay. However, at this time the Gulfstream was already beneath the Boeing 737. The initiated climb of the Gulfstream resulted in a TCAS instruction to climb for the Boeing 737.

The ATC controller of the sector TAU became aware of the situation due to the STCA indication on his monitor. He immediately issued the respective traffic information to the Boeing 737 crew. They reported to have the traffic in sight and that they would carry out their TCAS RA to climb.

The data from the Boeing 737 TCAS computer show that the Gulfstream was equipped with a mode S transponder. The data does not show, however, that the two computers communicated with each other. Moreover, the part "*Traffic Advisory Mode C Intruder*" allows the conclusion that the Boeing 737 TCAS generated its advisory based on the altitude information it received through the Gulfstream's transponder. This in turn indicated a not fully functional TCAS in the Gulfstream.

Conclusions

Findings

It is probable that the Gulfstream pilot mixed up the numbers of the clearance to descent (FL250) with the ones from the descent rate (vertical speed of 1,500 ft/min or more – fifteen hundred or more). This resulted in the conception that they were cleared to descent to FL150.

The deviation from procedures for transmission of numbers and altitudes resulted in an unintelligible radio communication. Thus, the ATC controller did not recognise the mix-up of FL250 and FL150. Besides, he expected the Gulfstream to stop their descent in FL250 because of the agreement between the two sectors.

The prescribed separation of 5 NM lateral and 1,000 ft vertical was infringed at a distance of 0.7 NM and 300 ft.

Causes

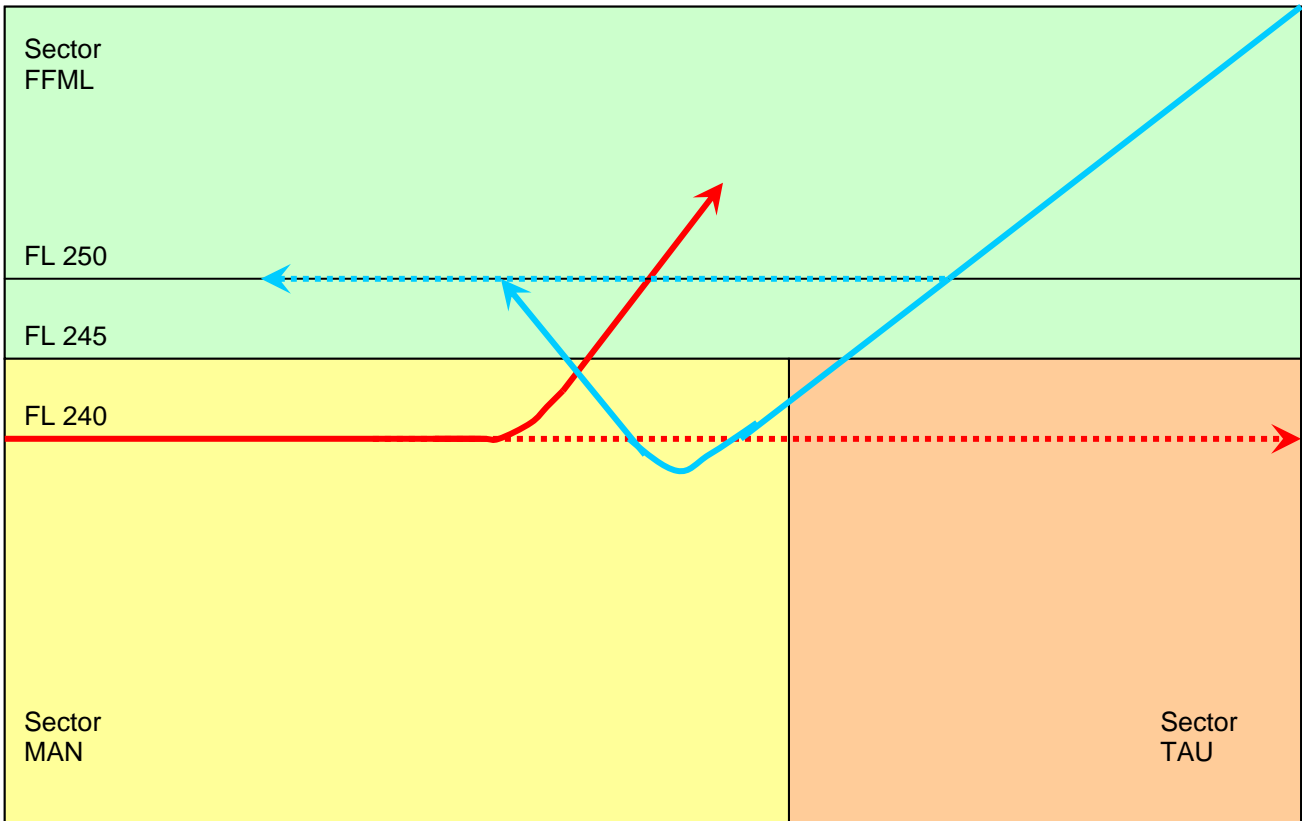
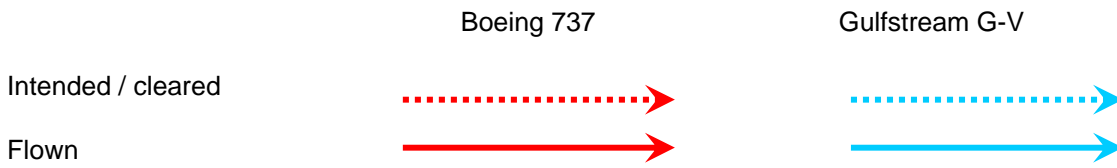
Based on error inducing communication between crew and ATC the Gulfstream continued to descent below the initially cleared altitude.

Deviation from standard phraseology of ICAO (International Civil Aviation Organisation) had contributed.

Investigator in charge	Hohensee
Assistance	Reuß, Severin

Appendices

Profile of the flight paths:



Shortened excerpt of the Boeing B737 TCAS computer

Rel. Time sec.	Intruder					Own		TCAS	
	Range NM	Range rate NM/Hr (=kt)	Altitude ft	C/D rate ft/min	Rel. Bearing Deg	Altitude ft	C/D rate ft/min	Advisory	RA for this intruder
94	13,22	-822	24.576	-1545	022	24.000	6	No	
96	12,75	-820	24.512	-1507	022	24.000	0	No	
98	12,31	-820	24.448	-1503	024	24.000	-13	No	
100	11,81	-819	24.384	-1871	025	24.000	3	No	
102	11,41	-815	24.320	-1773	027	24.000	-3	No	
104	10,94	-817	24.320	-1627	025	24.000	20	Traffic Advisory Mode C Intruder	
106	10,47	-813	24.256	-1518	027	24.000	40	Traffic Advisory Mode C Intruder	
108	10,03	-813	24.192	-1488	027	24.000	23	Traffic Advisory Mode C Intruder	
110	9,59	-810	24.128	-1908	027	24.000	37	Traffic Advisory Mode C Intruder	
112	9,09	-810	24.064	-1751	027	24.000	19	Traffic Advisory Mode C Intruder	
114	8,69	-806	24.000	-1616	027	24.000	-2	Traffic Advisory Mode C Intruder	
116	8,25	-801	24.000	-1091	028	24.000	-52	Traffic Advisory Mode C Intruder	
118	7,8	-801	23.936	-1091	028	24.000	-46	Traffic Advisory Mode C Intruder	
120	7,36	-794	23.936	-1020	028	24.000	-79	Traffic Advisory Mode C Intruder	
122	6,91	-794	23.872	-695	028	23.936	-60	Traffic Advisory Mode C Intruder	
124	6,48	-794	23.872	-464	027	23.936	-24	Traffic Advisory Mode C Intruder	
125	6,27	-792	23.872	-316	027	23.936	0	Resolution Advisory	Climb
127	5,83	-792	23.936	0	028	24.000	23	Resolution Advisory	Climb
129	5,38	-787	23.936	315	028	23.936	-36	Resolution Advisory	Climb
131	4,94	-783	24.000	1113	028	24.000	301	Resolution Advisory	Climb
133	4,52	-783	24.000	1140	030	24.000	817	Resolution Advisory	Climb
135	4,09	-778	24.064	1773	031	24.064	1372	Resolution Advisory	Climb
137	3,64	-771	24.128	1717	031	24.128	1747	Resolution Advisory	Climb
139	3,2	-766	24.192	2062	034	24.192	2385	Resolution Advisory	Climb
141	2,81	-761	24.256	1833	035	24.320	2932	Resolution Advisory	Climb
143	2,4	-757	24.320	1957	037	24.448	3165	Resolution Advisory	Climb
145	1,98	-748	24.384	1770	041	24.512	3247	Resolution Advisory	Climb
147	1,55	-736	24.448	1893	045	24.640	3247	Resolution Advisory	Climb
149	1,19	-717	24.512	1766	053	24.768	3352	Resolution Advisory	Climb
151	0,82	-675	24.576	1920	070	24.896	3375	Resolution Advisory	Climb
153	0,55	-583	24.640	1792	100	25.024	3307	Resolution Advisory	Climb
155	0,46	-349	24.704	1882	139	25.088	3202	Resolution Advisory	Climb
157	0,66	33	24.768	1762	165	25.216	3172	Resolution Advisory	Climb
158	0,84	245	24.768	1687	172	25.216	3142	Traffic Advisory Mode C Intruder	
160	1,3	639	24.832	1548	181	25.344	2977	Traffic Advisory Mode C Intruder	
162	1,82	924	24.896	1488	184	25.472	2812	Traffic Advisory Mode C Intruder	
164	2,32	1086	24.896	1061	186	25.536	2385	Traffic Advisory Mode C Intruder	
166	2,81	1146	24.960	871	188	25.600	1833	Proximity	
168	3,28	1132	24.960	768	190	25.600	1218	Proximity	
170	3,88	1132	24.960	768	190	25.600	643	Proximity	